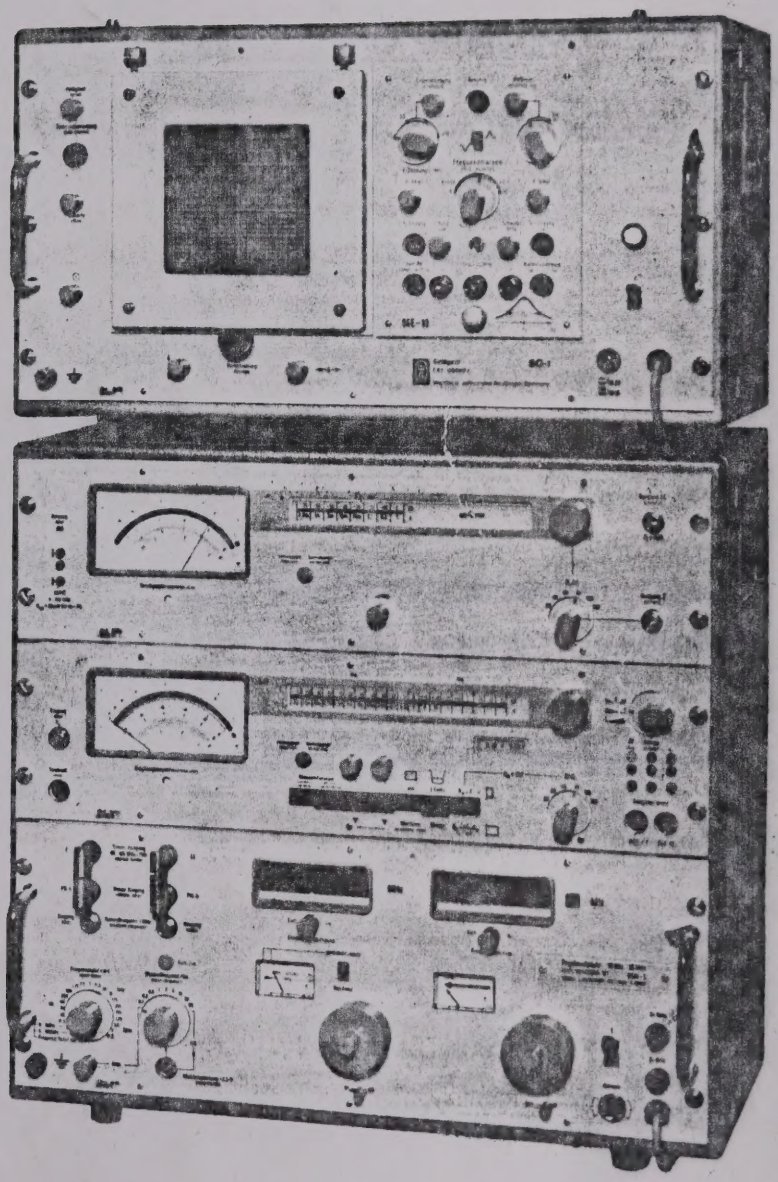
Description and
Operating Manual



Sweep Measuring Set

WM-50

for four-pole gain and attenuation measurements and display of frequency response in the frequency range 10 kHz to 36 MHz

SWEEP MEASURING SET WM-50

Frequency range 10 kHz to 36 MHz

Description and Operating Manual

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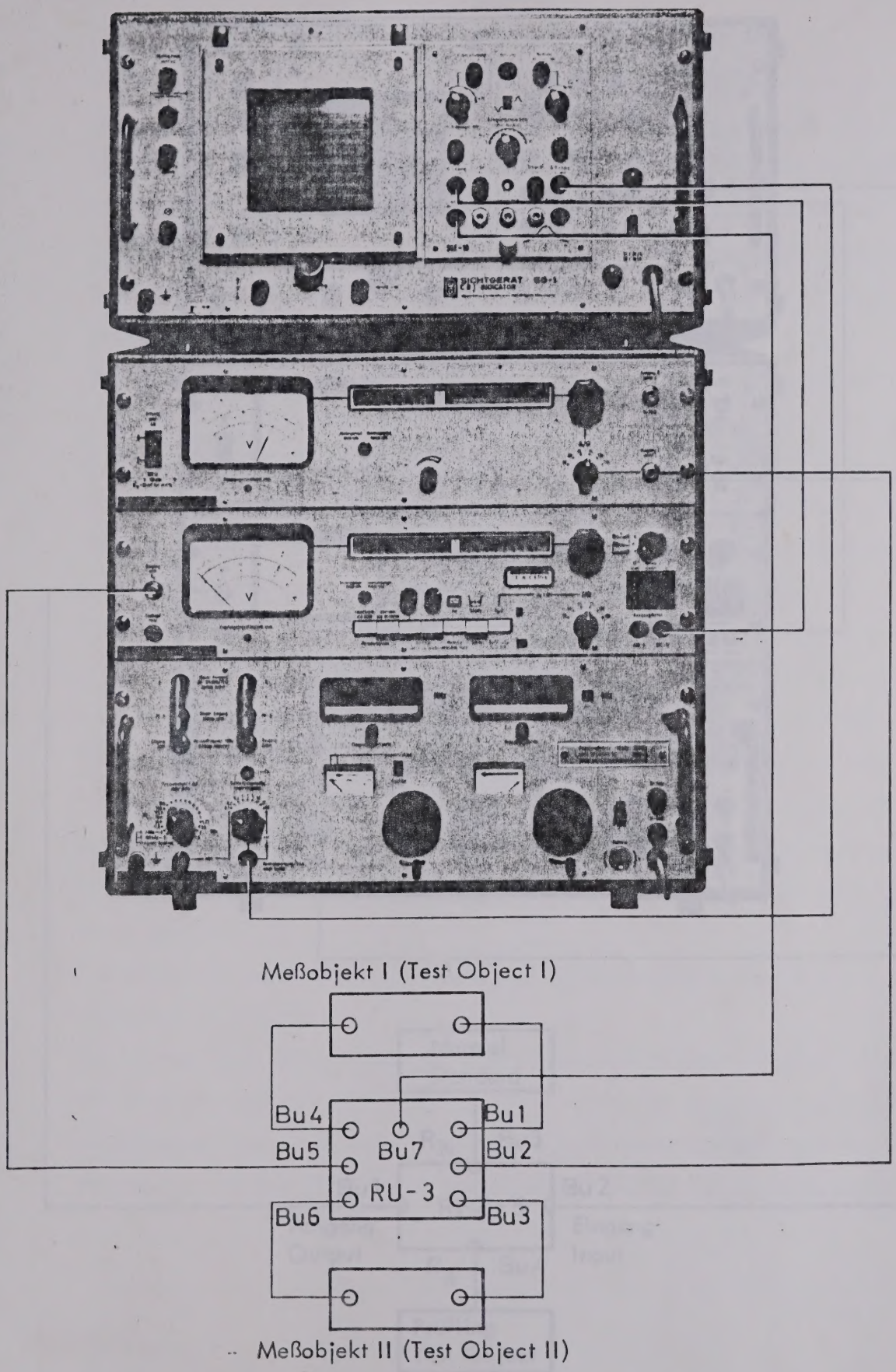


Bild 13 Zusammenschaltung WM-50 mit RU-3

Fig. 13 Interconnection of WM-50 with RU-3

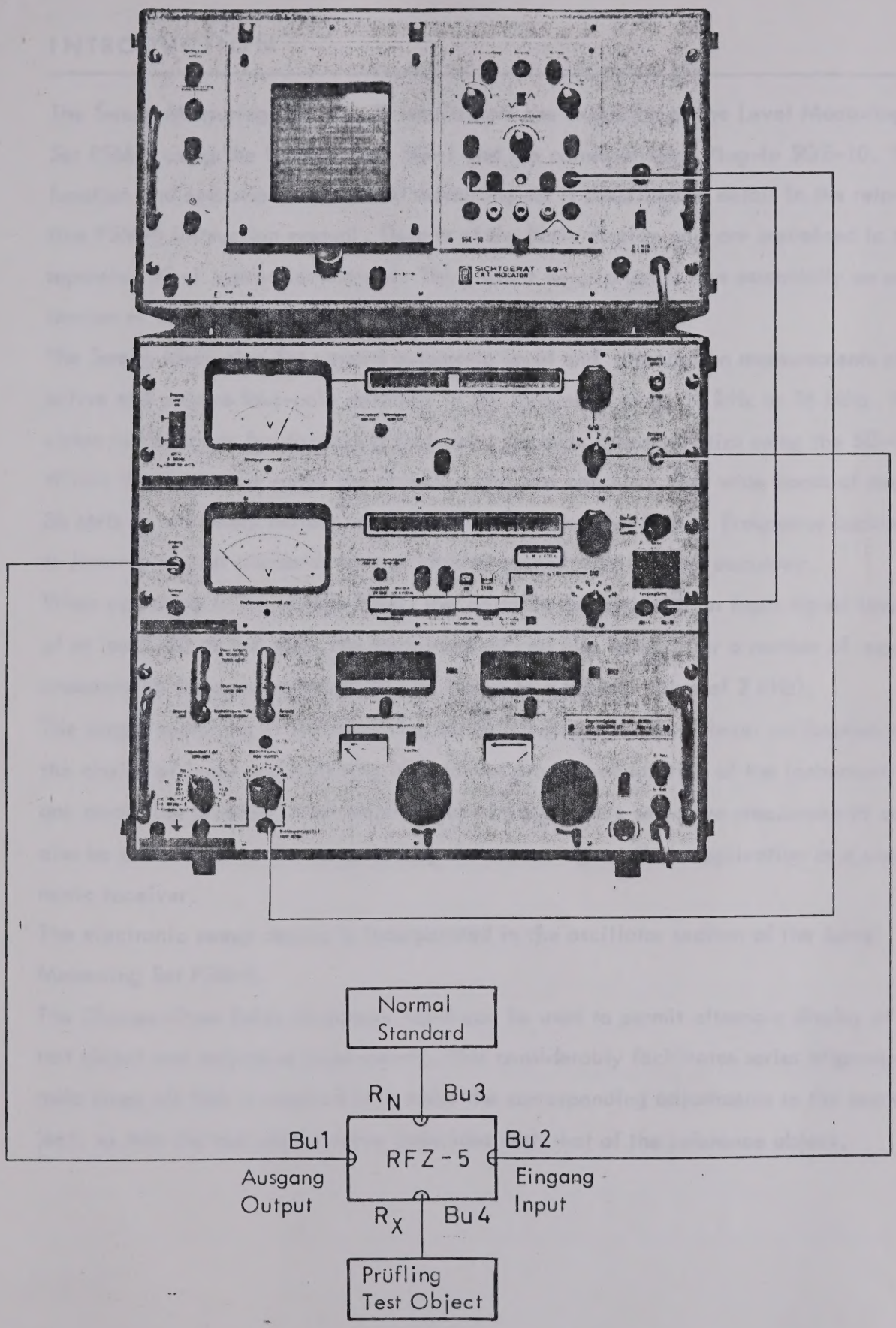


Bild 14 Zusammenschaltung WM-50 mit RFZ-5

Fig. 14 Interconnection WM-50 with RFZ-5

2. INTRODUCTION

The Sweep Measuring Set WM-50 results from the extension of the Level Measuring Set PSM-5 using the Display Unit SG-1 and the corresponding Plug-In SGE-10. The function and operation of the level measuring set is described in detail in the relative PSM-5 instruction manual. Details of the basic display unit are contained in the separate SG-1 instruction manual. The present description is thus essentially an extension of the PSM-5 instruction manual.

The Sweep Measuring Set permits automatic level and attenuation measurements of active and passive four-pole networks in the frequency range 10 kHz to 36 MHz. Provision is also made for displaying frequency response characteristics using the SG-1. Within this frequency range the objects under test can have very wide bands of max. 36 MHz or extremely narrow bands as for instance crystal filters. Frequency locking to internal crystal standards ensures high frequency stability and accuracy.

When operating in the narrow band, low noise mode, and with an input signal level of at least -60 dB (-7 Np), the measuring set can also be used for a number of measurements at frequencies below 10 kHz (down to a typical value of 2 kHz).

The simple switching of the measuring set from voltage to power level calibration and the choice of input and matching impedances provide adaptation of the instrument to any measuring problem in all major systems in use. Since selective measurements can also be carried out in the sweep mode, the measuring set finds application as a panoramic receiver.

The electronic sweep device is incorporated in the oscillator section of the Level Measuring Set PSM-5.

The Change-Over Relay Accessory RU-3 can be used to permit alternate display of test object and reference level curves. This considerably facilitates series alignment tasks since all that is required is to make the corresponding adjustments to the test object, so that the test object curve coincides with that of the reference object.

3. WM-50 MODE OF OPERATION

The Level Measuring Set PSM-5 is extended to constitute the Sweep Measuring Set WM-50 by the addition of the Display Unit SG-1 and its associated Plug-In SGE-10. The individual instruments PSO-5 (Signal Generator) and PMO-5 (Level Meter) can also be combined with the Display Unit to form a sweep measuring set. In this case, however, use is required of control cables for the tuning frequency and standard frequency between the two instruments. External tuning facilities are described in detail in the PSM-5 instruction manual.

A sawtooth generator accomodated in the oscillator section RWO-5 affords synchronous sweeping of the PS-5 output frequency and the PM-5 receive centre frequency by means of its variable sawtooth voltage. The sawtooth generator also effects the horizontal deflection of the display unit trace.

The frequency of the sawtooth generator, i.e. the sweep frequency, can be adjusted in 9 steps between 0.1 Hz to 50 Hz. Manual deflection is also provided when a sweep curve requires slow tracing as is the case during alignment, for example.

An additional capacitor can be connected to a display unit socket in parallel with the sawtooth generator output socket, thus enabling sweep frequencies of less than 0.1 Hz.

The sweep width can be varied in 19 steps between ± 17.5 Hz and ± 17.5 MHz. This is achieved by applying the sawtooth current to points of different sensitivity ($\Delta f/\Delta i$) of the frequency control circuit in the RWO-5 section. A comprehensive RWO-5 functional description with reference to the sweep mode is contained in the section 'Function of Individual Units' of this manual. When the Generator Unit PS-5 is used as a sweep generator, the frequency response error of the output level must be a minimum. To achieve this, a d.c.voltage derived from the output level is amplified and compared with a standard voltage via a differential amplifier. The output voltage of the differential amplifier is fed to the final control element of a control circuit which corrects the output level.

Six different output impedance values between 50 Ω und 150 Ω can be selected on the generator thus facilitating matching of the instrument to any test object.

The receiver PM-5 supplies the signal required for the vertical deflection of the display unit.

In linear display mode of the receive signal an amplitude range of only approx. 10 : 1 (20 dB) can be displayed. As is the case with a number of measurements, for instance of filter rejection properties as well as frequency spectrum analysis etc., much greater level differences occur. Such measurements can be achieved by including a logarithmic amplifier prior to the PM-5 final amplifier, whereby the screen of the Display Unit SG-1 must be provided with a graticule plate having a linear Y-axis ruling.
The instrument can be switched to either low-noise or low-distortion measuring mode, the latter being of interest especially for swept frequency measurements since in this mode the noise level can be maintained small. To match the instrument to all usual characteristic impedance values, the input impedance can be switched to various values between 50 Ω and 150 Ω. A switch position 'high impedance' ($Z_{in}=\infty$, $C_{in}\approx 30$ pF) is also provided.
With the aid of a button the PM-5 meter can be switched during sweeping thus effecting indication of a reference line level instead of the receive level. The reference line (measuring line) is injected in the swept trace and serves to calibrate the screen in the Y-direction.
The Display Plug-In Unit SGE-10 supplies the deflection voltage in a suitable form to the X and Y-deflection amplifiers of the Display Unit SG-1.
At this plug-in the amplitude and polarity of the deflection signals can be varied, thus permitting optional display of the Y-signal as an attenuation or gain characteristic and enabling the trace deflection to occur from either left to right or vice versa.
During the sawtooth return a square pulse from the sawtooth generator of the RWO-5 arrives at the display plug-in unit, whereby the Y-signal is blanked to zero via a blanking gate thus effecting display of the zero line.
With the aid of a d.c. amplifier which can be switched into circuit the Y-amplitude can be expanded by the factors 2, 5 or 10. To observe any portion of the expanded display a potentiometer is provided for shifting as desired.
By effecting alternative display of the Y-deflection voltage and an adjustable d.c. voltage an additional reference line results, which serves — as previously mentioned — to calibrate the screen in the Y-direction. The corresponding level value is indicated on the PM-5 meter which is switched to the position 'ref.line' (measuring line) in the sweep measuring mode.

A frequency marker generator in the SGE-10 permits the injection of frequency markers which are visible on the Y-signal and the reference line. For this purpose, a generator is connected to the display plug-in unit, the former supplying the constant marker frequency f_2. The marker voltage is converted into needle pulses and then the frequency spectrum $n \cdot f_2$ is mixed with the swept frequency f_1. When the signal frequency corresponds to the marker frequency or one of its harmonics, an L.F. difference frequency voltage results at the mixer output used for marker triggering.
When a generator with the frequency f_3 is connected to the Display Plug-In SGE-10, sideband markers can be injected into the display; whereby the band centre frequency is formed from the marker frequency.

Y-Output (socket Bu 205/1,2)

approx. 45 to 90% of input voltage with Z_{out} = 20 kΩ to 50 kΩ depending on position of potentiometer P 204.

X-Output (socket Bu 205/4,5)

approx. 25 to 100% of input voltage with Z_{out} = 0 to 25 kΩ depending on position of potentiometer P 203.

Control signals (socket Bu 202/2) for Change-Over Relay RU-3

In mode 'ref. line OFF' : signal corresponds to return pulse at Bu 203/2

In mode 'ref. line ON' : step voltage of +18 V across capacitor 2.2 nF

Current consumption at 110 V . . . . . 60 mA

1.3. Change-Over Relay Unit RU-3 / BN 323

Frequency range . . . . . d.c. to 36 MHz

Input and Output

Impedance (sockets 2.5/6 mm) . . . . . 75 Ω

Reflection factor

from d.c. to 15 MHz . . . . . ≦ ± 0.015

above 15 MHz to 36 MHz . . . . . ≦ ± 0.03

Insertion loss . . . . . ≦ 0.05 dB (0.006 Np)

Difference of insertion loss
in both channels . . . . . ≦ 0.02 dB (0.0023 Np)

Coupling attenuation between
both channels . . . . . ≧ 95 dB (11 Np)

Number of change-over operations (open-circuit) . . . . . 10^8 operations

Change-Over

Change-over frequency, internally triggered, continuously adj. . . . . 1 to 30 Hz

externally triggered (Bu 7) . . . . . d.c. to 30 Hz

Manual change-over

4. FUNCTION OF INDIVIDUAL UNITS

4.1. Oscillator Unit RWO-5

The tasks required of the oscillator unit in the Sweep Measuring Set WM-50 are as follows :

a) Generation of a sweep frequency to effect common tuning (tracking) of the generator and receiver.

b) Generation of a horizontal deflection voltage for the display unit.

c) Generation of a trigger pulse during sawtooth retrace for blanking the Y-deflection signal and for switching a multivibrator in the Display Plug-In Unit SGE-10.

d) Adjustment of the sweep width in 19 steps.

e) Adjustment of the sweep frequency in 9 steps.

The function of the oscillator unit in the sweep measuring mode is illustrated in the adjacent block circuit diagram (Fig. 2) :

The frequency f_2 of the control oscillator is mixed with the frequency f_g of the coarse tuning oscillator in the mixer M 1. A low-pass filter selects the product $f_2 - f_g$ from which the discriminator D 2 produces a frequency proportional direct current. This d.c. is opposed by a current formed by the discriminator D 3 from the frequency f_i of the incremental tuning (interpolation) oscillator. Thus for the condition $f_2 - f_g = f_i$ the sum current i_2 of the discriminators equals zero. When the frequencies deviate from each other, the current i_1 which is applied to the linearisation circuit of the control oscillator from discriminator D 1 is superimposed by the correction current i_2. This correction current effects re-tuning of the control oscillator G 2 until the mixture product $f_2 - f_g$ and the frequency f_i differ by not more than the control error between the two discriminators D 2 and D 3, thus that the frequency difference is within the locking range of the phase discriminator D 4. The discriminator then supplies a correction current i_3 which is also added to i_1 and which causes G 2 to be re-tuned until the frequencies $f_2 - f_g$ and f_i are exactly equal. In the swept frequency mode the variable sawtooth current supplied by the sawtooth generator G 5 is depending on the position of the sweep-width selector applied to different points of the control circuit

as an additional control current (interference current).

In positions 3 to 12 of the sweep-width selector S 1602, i.e. from ± 17.5 Hz to ± 17.5 kHz, the variable sawtooth current is applied to a reactance circuit in the incremental tuning (interpolation) oscillator. This circuit acts as an inductance in parallel to the oscillator circuit inductance. This results in the sweep current changing the frequency of the interpolation oscillator causing as previously mentioned a change of current i_2 and of the control frequency f_2 across the discriminator D 3. All of the discriminators remain in operation, i.e. the frequency and phase control continues to function. The adjusted image centre frequency is maintained 'crystal locked'. A residual error of max. 3 % of the adjusted sweep width results from a slight difference between the threshold voltage of diode GI 1804 and of the emitter-base circuit of T 1809.

The sync. indication for tuning of the incremental tuning oscillator (J 2301) is rendered inoperative by a current which maintains the meter needle at f.s.d. The locking indication of the coarse tuning oscillator (J 2302) remains operative thus indicating that the selected centre frequency is 'locked'.

In the positions 13 to 17 of the sweep-width selector (± 35 kHz to ± 700 kHz sweep width) the sawtooth current is superimposed as a disturbance variable on the output current i_2 of the discriminators D 2 and D 3. The phase discriminator D 4 is switched out of circuit since its pull-in range of 155 kHz is then smaller than the sweep-width range. Thus only the frequency control circuit remains operative which corrects the disturbance variable (i.e. the superimposed sawtooth current). This results in a change of the control frequency corresponding exactly to the slope $\Delta f / \Delta i$ of the characteristic of the counting discriminators D 2 and D 3. The average slope is 1 MHz/1 mA, i.e. for a change of 1 mA of the superimposed interference current the frequency of the control oscillator changes by 1 MHz.

The image centre frequency in the sweep frequency range ± 35 kHz to ± 700 kHz has a maximum error of 3 % of the adjusted sweep width ± 70 kHz. This additional error of ± 70 kHz results from the error inherent in the frequency control.

When switching from the sweep-width position '± 17.5 kHz' to '± 35 kHz' the adjusted centre frequency also introduces the error inherent in the frequency control. The frequency range of interest is thus shifted out of display screen. By correcting the frequency of the incremental tuning oscillator the signal to be displayed can be re-positioned

into the screen centre. The scale of the incremental tuning oscillator indicates the amount by which the new centre frequency deviates from the original centre frequency.

The frequency adjusted with the coarse tuning oscillator is still crystal locked as indicated on meter J 2302.

To generate the four largest sweep widths (± 1.75 MHz to ± 17.5 MHz) the sweep current is fed directly to the linearizing circuit of the control oscillator. Here it acts as a true control current and not as a disturbance variable. The frequency control circuit is inoperative in the above selected sweep-width positions due to its control range being insufficient. The interpolation oscillator is no longer effective in adjusting the centre frequency: this is now achieved solely be the coarse tuning oscillator. The frequency of the coarse tuning oscillator is then no longer locked as indicated by full-scale deflection of the meter J 2302. This results, of course, in the error of the adjusted centre frequency becoming larger, attaining a maximum of 3 % of the adjusted sweep frequency width ± 500 kHz. This ± 500 kHz includes the error resulting from the deviation of the control frequency from the coarse tuning oscillator frequency when the linearisation is controlled only by the discriminator current i_1.

The additional superimposed sawtooth control current results in a change of the control frequency corresponding exactly to the slope $\Delta f/\Delta i$ of the discriminator D 1 characteristic. The average slope is 1 MHz / 0.2 mA, i.e. for a change of 1 mA of the introduced interference current the control oscillator frequency changes by 5 MHz. When switching from position '± 700 kHz' to '± 1.75 MHz' of the sweep-width selector the trace is again shifted out of the display screen. This can be corrected by slightly changing the frequency of the coarse tuning oscillator.

The sweep frequency can be adjusted between 0.1 Hz and 50 Hz by means of switch S 1601. This permits the frequency rate of change (3.5 Hz/s to 1.75 GHz/s) to be adapted to the transient period of the test object.

For arbitrary sweeping of a measuring curve, e.g. for alignment purposes, manual variation of the sweep frequency is provided.

An external sweep frequency can be applied at the sweep voltage output socket Bu 1601 (RWO-5 front panel), whereby the switch S 1601 'Sweep Frequency' must be positioned to 'ext'. By connecting an additional capacitor to this socket, the internal sweep frequency can be reduced to less than 0.1 Hz in position '50 Hz' of the sweep

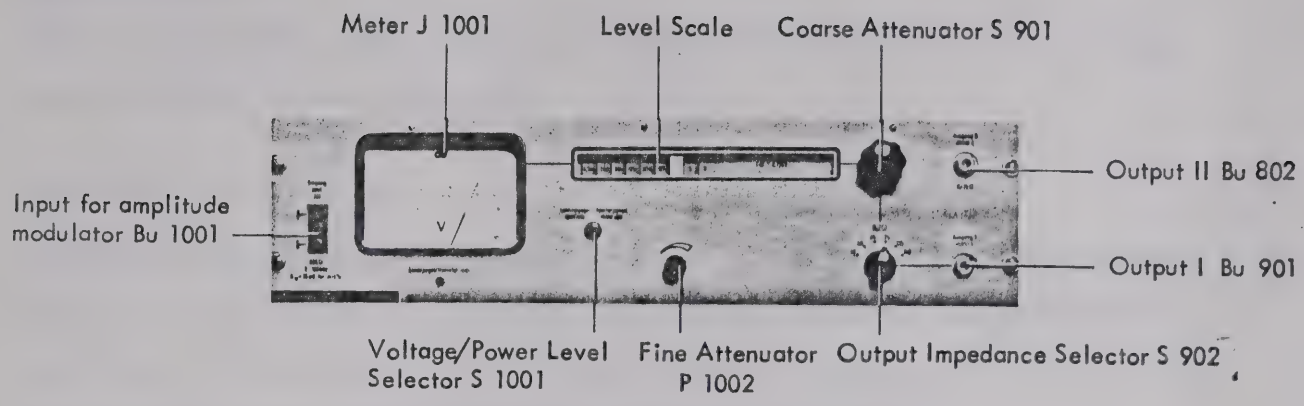


Fig. 3 Generator Unit PS-5

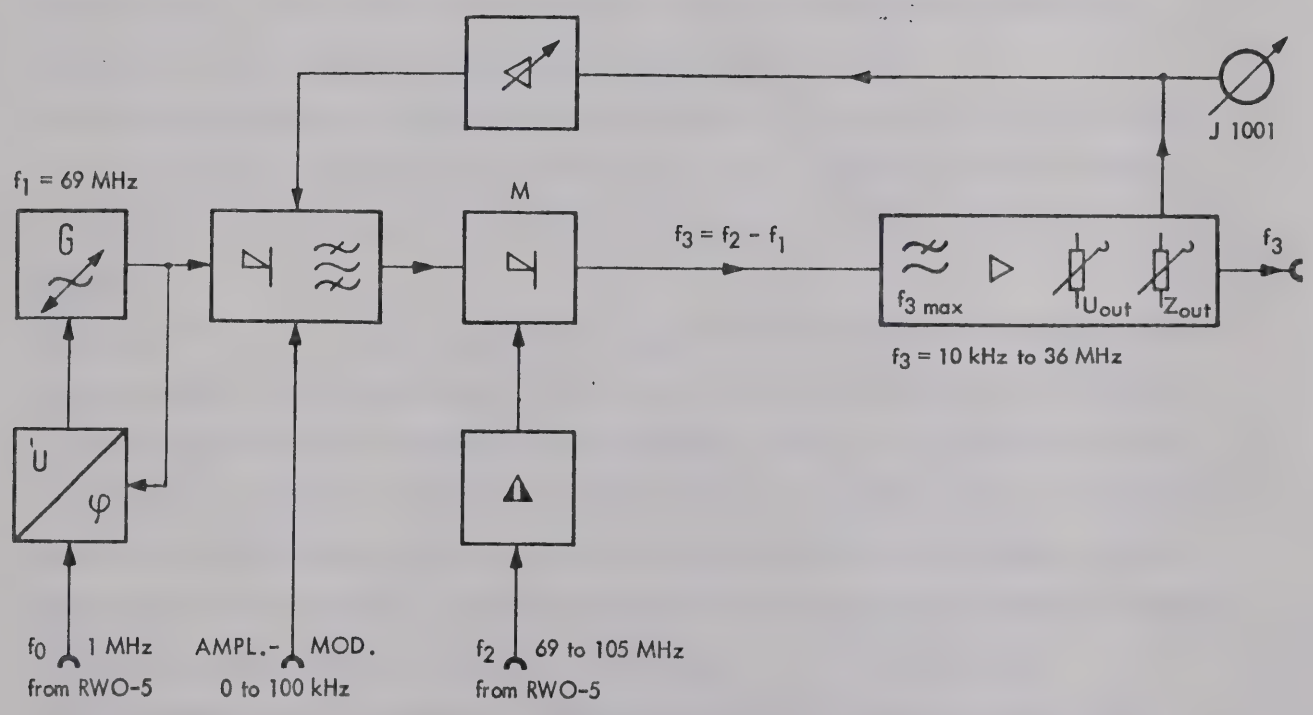


Fig. 4 PS-5 Block Circuit Diagram

frequency selector.

The mode of operation of the oscillator unit is described in detail in the Level Measuring Set PSM-5 Instruction Manual.

4.2. Generator Unit PS-5

The PS-5 is a beat-frequency generator. Its output frequency f_3 is the difference from the RWO-5 control frequency f_2 and the fixed frequency f_1 of 69 MHz generated in an oscillator of the generator unit. f_1 is then locked in the phase discriminator to the 69th harmonic of the standard frequency oscillator in the RWO-5.

The output frequency of the 69 MHz oscillator is applied to the mixer through an amplitude modulator and a 69 MHz band-pass filter for rejecting the harmonic of 69 MHz. The difference frequency f_3 equal to $f_2 - f_1$ is then selected from the resulting mixer products by a following low-pass filter. The mixer is gated by the control voltage (frequency f_2) which is previously converted into a square-wave voltage by an amplifier-limiter. This results in the conversion transconductance being practically independent of the control voltage amplitude and frequency (f_2).

The difference frequency voltage (f_3) at the output of the low-pass filter is amplified and is fed through a calibrated attenuator and an output impedance selector to the output sockets of the generator unit. The rectified output voltage is indicated by meter J 1001.

When the PS-5 is used as a sweep frequency generator the frequency response error of the output level must be a minimum. To this end a d.c.voltage derived from the output level is amplified and compared with a standard voltage via a differential amplifier. The output voltage of the differential amplifier is applied to the amplitude modulator which in this control circuit has the function of a final control element. Here the output level is corrected. To adjust the output level the standard voltage is varied; a ten-turn potentiometer ensuring accurate adjustment of the output level.

The instruction manual for the Level Measuring Set PSM-5 contains a detailed description of the generator section.

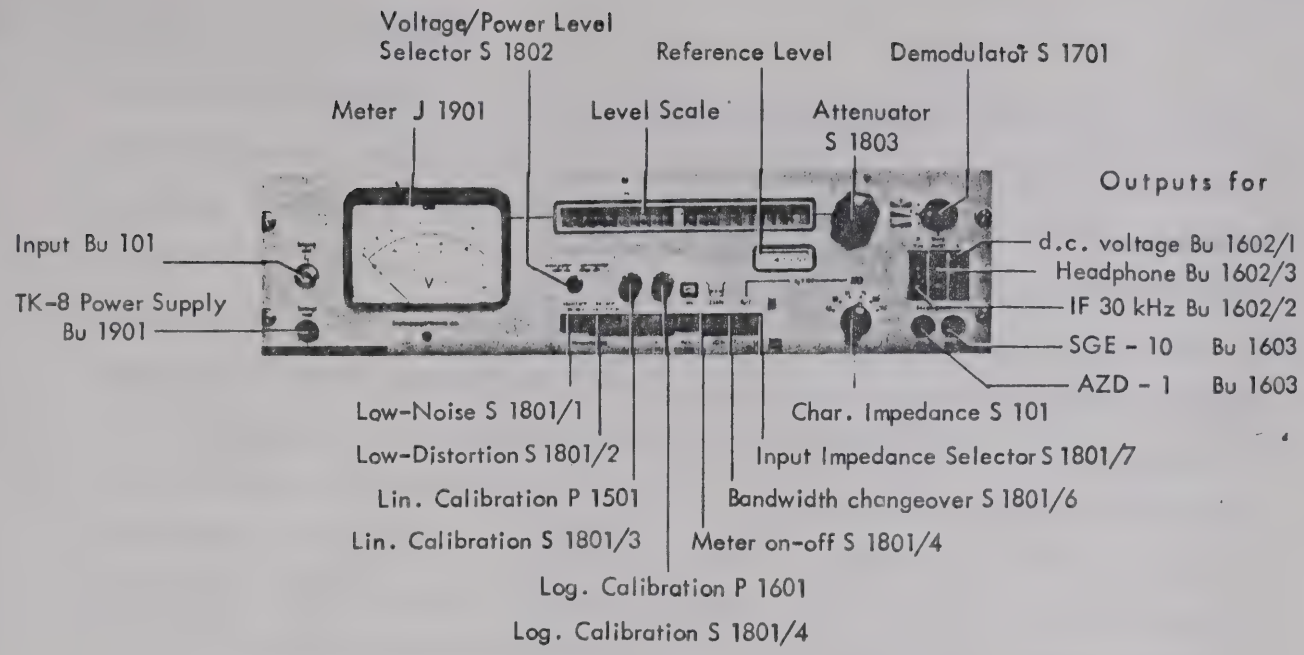


Fig. 5 Receiver Unit PM-5

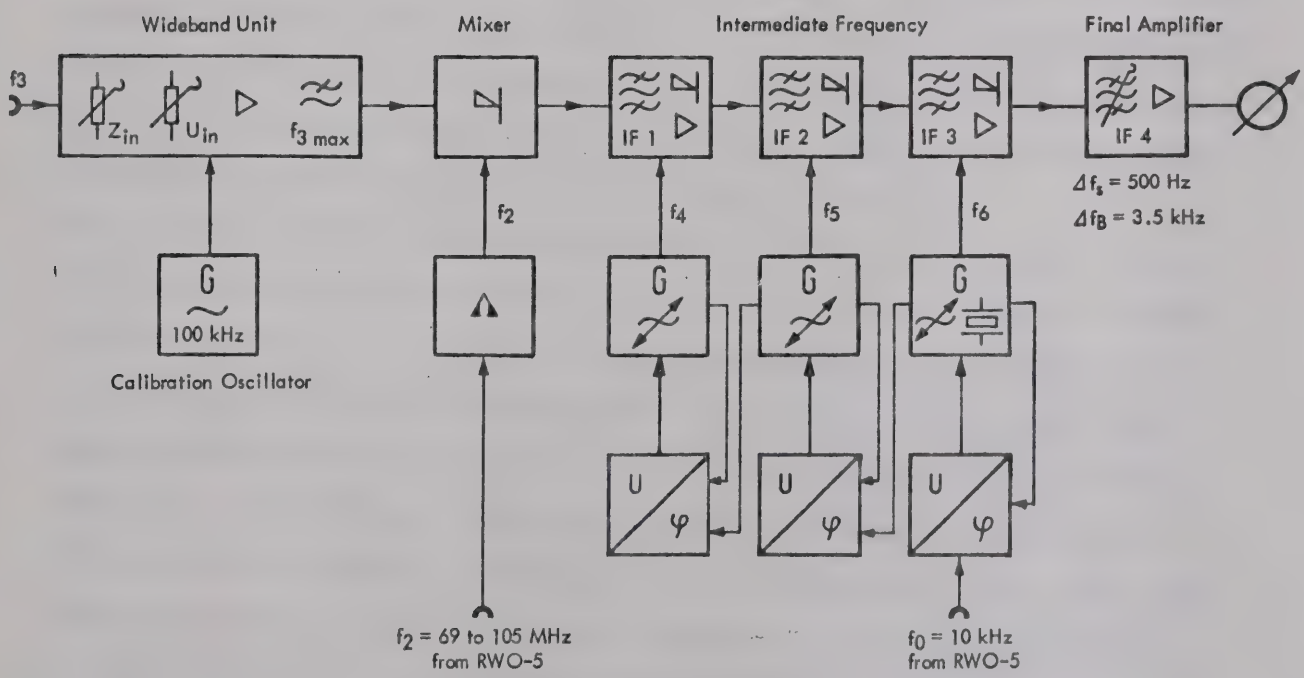


Fig. 6 PM-5 Block Circuit Diagram

4.3. Receiver Unit PM-5

The Receiver Unit PM-5 operates on the heterodyne principle. The receive signal is applied through a wideband section to the mixer where it is converted by the control frequency f_2 into the fixed 1st intermediate frequency. Since at this high frequency of 69 MHz, however, it is impossible to achieve the required selectivity for the receiver, the 1 st IF is reduced by a threefold conversion into a frequency range in which the design of band filters having the desired selectivity is facilitated. The bandwidth of the last band filter (IF 4 = 30 kHz) can be switched between 500 Hz and 3.5 kHz. From this band-pass filter the signal is applied to the final amplifier where it is amplified, rectified and fed to the receiver meter for indication. In the linear indicating mode of the receive signal, only an amplitude range of approx. 10 : 1 (20 dB) can be indicated on the meter or displayed (in swept frequency operation) on the SG-1. Much larger attenuation differences occur, however, in a number of measurements, e.g. testing the rejection properties of filters, frequency spectrum analyses, etc. For such measurements a logarithmic amplifier can be inserted prior to the final amplifier.

Logarithmation is achieved by silicon diodes which have a logarithmic current-voltage characteristic over a wide range. The silicon diodes represent the load resistance of a 30 kHz amplifier stage acting as current source. The change in resistance of the silicon diodes is effected by a direct voltage which is proportional to the output voltage and which is applied to the diodes via a gain-controlled amplifier.

The drive characteristic of the instrument is thus logarithmic over a range of 100 dB (dB instrument) or 10 Np (Np instrument). The instrument is provided with an attenuation scale calibrated in 10 dB or 1 Np steps respectively. The graduation of this scale corresponds to that of the voltage scale in the linear indication mode and is easily transferred to a display unit or a recorder. The instrument can be switched to 'low-noise' or 'low-distortion' operation. The latter mode is of interest especially during sweep measurements. To match the instrument input to all common cable and system characteristic impedances an input impedance selector is provided having six positions from 50 Ω to 150 Ω. The input can also be switched to 'high impedance' ($R_{in} = \infty$, $C_{in} \approx 30$ pF).

A detailed description of the receiver unit is contained in the PSM-5 instruction manual.

4.4. Display Unit SG-1

The Display Unit SG-1 is a C.R.T. unit of special design having a useful screen area of 10 cm x 10 cm. The tube is afterglowing and of low distortion. Its display accuracy is equivalent to the accuracy of a good pointer meter. The SG-1 has controls for horizontal and vertical shift and for adjusting the intensity. For adapting the display unit to the PSM-5 measuring set the Display Plug-In Unit SGE-10 is provided.
A more detailed description of the Display Unit SG-1 is contained in a separate manual.

4.5. Display Plug-In Unit SGE-10

The tasks required of the SGE-10 in the Sweep Measuring Set WM-50 (i.e. the combination of PSM-5 and SG-1 with SGE-10) are as follows:

a) Adjustment and pole-reversal of the horizontal deflection voltage supplied by the Oscillator Unit RWO-5.

b) Adjustment, amplification, shifting, blanking and pole-reversal of the vertical deflection voltage supplied by the Receiver Unit PM-5.

c) Generation of the voltage for the Y-measuring trace (reference line).

d) Control of the Change-Over Relay Unit RU-3.

e) Generation of frequency and sideband markers.

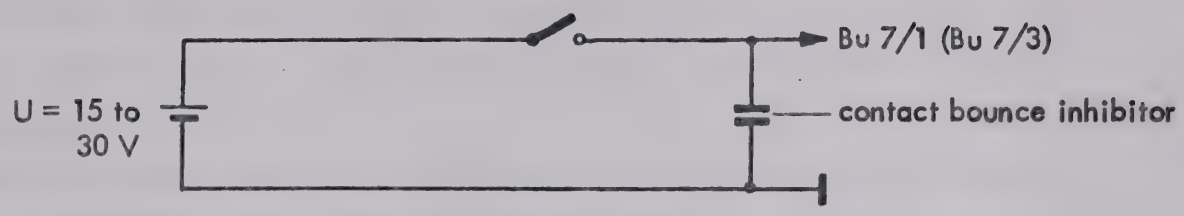
4.5.1. X-Deflection

Either a sawtooth voltage of U_{peak}=3.5 V or a variable d.c.voltage is applied to the X-input (socket Bu 203) of the display plug-in. The former voltage is supplied by the RWO-5 sawtooth generator unbalanced and free of d.c.. The variable d.c.voltage covers a range of -3.5 V to + 3.5 V and is used for manual deflection, whereby the switch S 1601 for adjusting the sweep frequency on the RWO-5 is positioned to 'manual'. Potentiometer P 1601 located on the RWO-5 front panel permits adjustment of the deflection voltage in the manual sweep mode. The X-amplitude is varied in the SGE-10 with potentiometer P 203. Shifting of the X-amplitude is achieved with a potentiometer on the SG-1 front panel. During the sawtooth forward trace the deflection voltage increases in the positive direction and also the signal frequency. Since the

External Trigger Pulse (Bu 7/2)

Pulse base	d.c. to 0.5 V
Pulse crest	+5 to +10 V
Rise time	≦ 100 µs
Pulse duration	≧ 10 µs
Max. input current	0.25 mA

Contact switching via sockets Bu 7/1 or Bu 7/3



Contact Loading

Max. switching power	7 W
Max. switchable current	0.25 A
Max. switchable voltage	30 V

Mains voltage	110, 120, 220, 240 V ± 10 %
Series A and B	110, 220 V ± 10 %
Mains frequency	45 to 65 Hz
Power consumption	5 VA

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display of frequency-dependent functions is usually carried out with the frequency increasing from left to right, it is obvious to arrange for the X-deflection to trace from left to right also in the Measuring Set WM-50. For special applications the deflection direction can be reserved with the polarity change switch S 202. This switch is located on the rear panel of the plug-in, it normally not being required for conventional measurements.

4.5.2. Y-Deflection

The Y-deflection voltage is provided by the Receiver Unit PM-5 and is applied to the SGE-10 at socket Bu 201. At f.s.d. on the PM-5 meter this voltage is 6 V at an output impedance of 10 kΩ.

The Y-deflection signal is applied to the Y-amplifier of the display unit via a blanking gate, an amplitude control and a change-over switch.

Since the sweep voltage has a sawtooth waveform, the rate of change of frequency during retrace is considerably higher than during the forward trace. This would lead to transient distortions in most cases and thus result in different forward and return traces. To avoid this effect the sawtooth retrace interval is utilized for tracing the zero line. For this purpose a square wave pulse from the RWO-5 sawtooth generator is applied to the blanking gate via socket Bu 203. Zero Y-deflection voltage at the plug-in (e.g. when the receiver unit is out of circuit) results in two closely spaced horizontal lines appearing on the screen; one line corresponds to zero receive voltage and is generated during the sawtooth forward trace, the other is the retrace voltage blanked to zero ('absolute zero line').

Using the potentiometer P 202 the potential of the zero line derived from the signal voltage can be varied so that this line coincides with the above mentioned 'absolute zero line'. The displayed zero line thus represents the actual zero signal voltage.

The potentiometer P 204 ('Y-Amplitude') permits the Y-sensitivity to be varied. The switch S 204 is used to effect display of either gain or attenuation curves.

Y-Expansion

When the switch S 203 for Y-expansion is positioned to 'x 2', 'x 5' or 'x 10' the Y-deflection voltage is applied through a d.c. amplifier with negative feedback. Am-

plification factors of 2 or 5 or 10 can be achieved by selecting one of three different negative feedback values with S 203. The potentiometer P 205 ('Y-position') permits vertical shifting of the oscillogram thus enabling any portion of an expanded display to be examined. When the expansion amplifier is out of circuit (S 203 in position 'x 1') P 205 is inoperative. In this case Y-shifting is achieved with a control on the front panel of the basic unit SG-1.

4.5.3. Y-Reference Line

For exact voltage and level measurements in the swept frequency mode a continuously variable d.c.voltage and the signal voltage are displayed alternately and periodically with the X-deflection sawtooth voltage. The d.c.voltage (reference line voltage) is indicated by the receiver unit meter which must be switched out of circuit in the sweep mode, thus enabling a sweep measurement to be carried out with the accuracy of a meter measurement. An advantage of this procedure is that all of the voltage or level meter scales can be made use of.

The resolution of the reference line display can be enhanced by supplementing the Receiver Unit with the Scale Expander Accessory AZD-1, thus enabling ± 1 dB (± 0.1 Np) sections of the PM-5 meter scale to be expanded to a scale length of approx. 100 mm.

Switching between signal voltage and measuring line (reference line) voltage is achieved by two reed relays triggered from a bistable multivibrator in the SGE-10. The multivibrator is gated by the retrace pulse which is applied to the plug-in from the RWO-5 as previously described.

The multivibrator is turned on and off by means of switch S 201 ('reference line'). The switch position dictates also the clock frequency of the Change-Over Relay RU-3 (see 4.6.) which can be added for comparison measurements between the test object and a standard. In the position 'reference line OFF'the Change-Over Relay is triggered directly by the retrace pulse of the sawtooth voltage : i.e. change-over is effected at sweep frequency. In the position 'reference line ON' the change-over pulses are applied to the RU-3 from the SGE-10 multivibrator, which then have half the sweep frequency. This results in the following measuring sequence : object I - ref. line - object II - ref. line.

The change-over relay can thus be operated with the ref.line facility switched on.

4.5.4. Frequency Markers

Frequency response characteristics of various kinds, for instance attenuation, delay or impedance as a function of the frequency can be automatically plotted by means of frequency response recorders or displayed by sweep measuring instruments, whereby certain frequencies can be identified with the aid of frequency markers. The method used here is based on the comparison of the swept frequency f_1 with a constant reference frequency, i.e. the marker frequency f_2. When the marker frequency voltage is converted into needle pulses and mixed with the signal frequency f_1 a low-frequency difference voltage is obtained for all multiples of the marker frequency at the mixer output. This voltage is utilized for marker triggering. The marker frequency f_2 is applied to the plug-in from an external generator connected to socket Bu 403.

The width of the frequency markers is adjusted with the switch S 401. Two potentiometers P 301 and P 302 serve to adjust the threshold for frequency marker triggering and the frequency marker height.

Connecting a generator of frequency f_3 to socket Bu 401 enables sideband markers to be generated. The band centre frequency is then formed by the marker frequency. Namely, when the frequency of the main marker ($f_1 - nf_2$) approaches the sideband frequency f_3, sideband-markers result spaced at intervals of f_3 to the right and left of the original frequency marker.

The sideband markers are suitable for the measurement of relatively narrow bands, as is the case for instance with bandpass filter and bandstop filter measurements.

4.5.5. External Instrument Connections

The Display Plug-In Unit is provided with a socket Bu 205 for connection of a recorder or a display unit for demonstration purposes. Here the signals for X and Y-deflection are available. When the plug-in is connected to the Oscillator Unit RWO-5 the socket Bu 1601 on the RWO-5 front panel is no longer accessible for further connections. It can be, however, that this socket is required for insertion of an additional capacitor or application of an external deflection frequency.

For this purpose the socket Bu 204 of the SGE-10 is provided in parallel to the socket Bu 203 and thus to the sweep voltage socket Bu 1601 of the oscillator unit also.

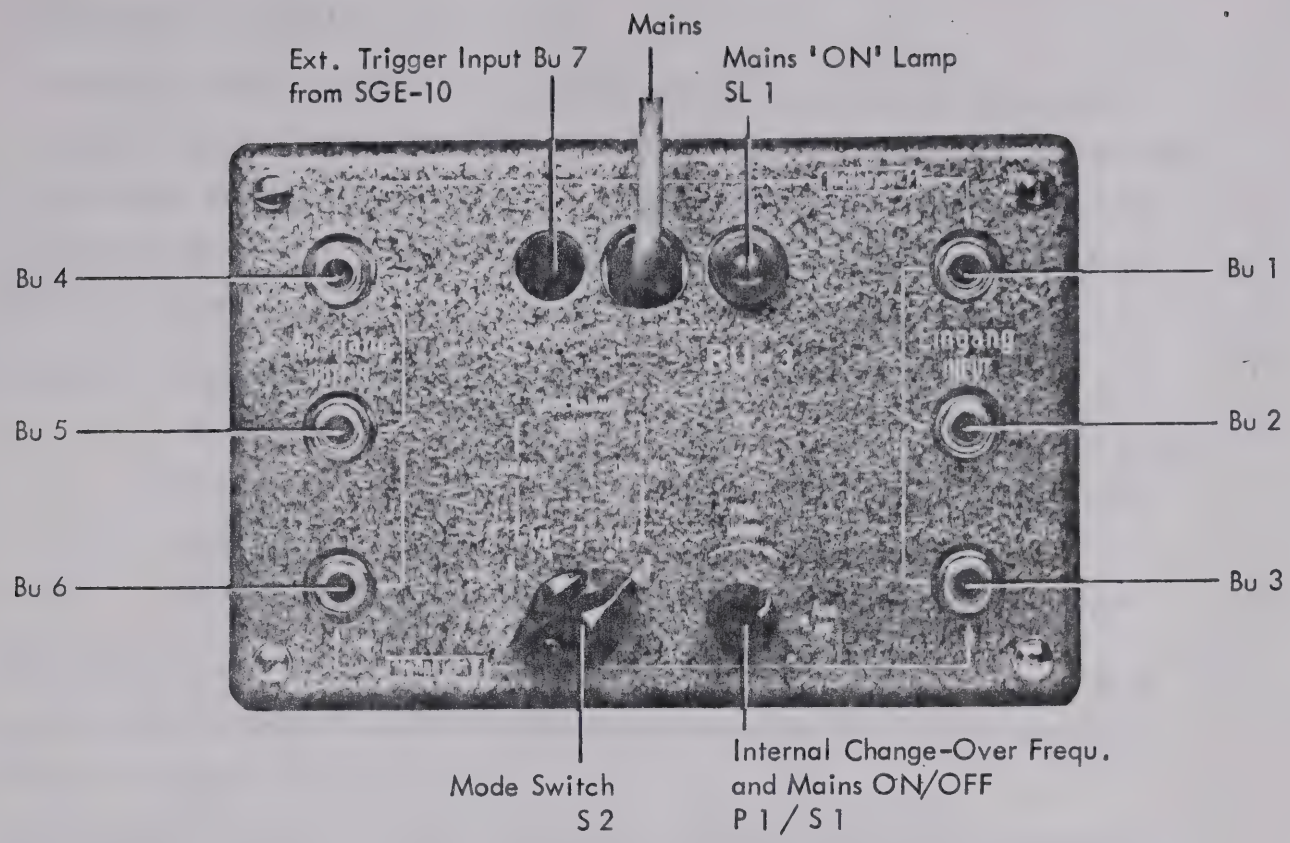

Fig. 9 Change-Over Relay Unit RU-3

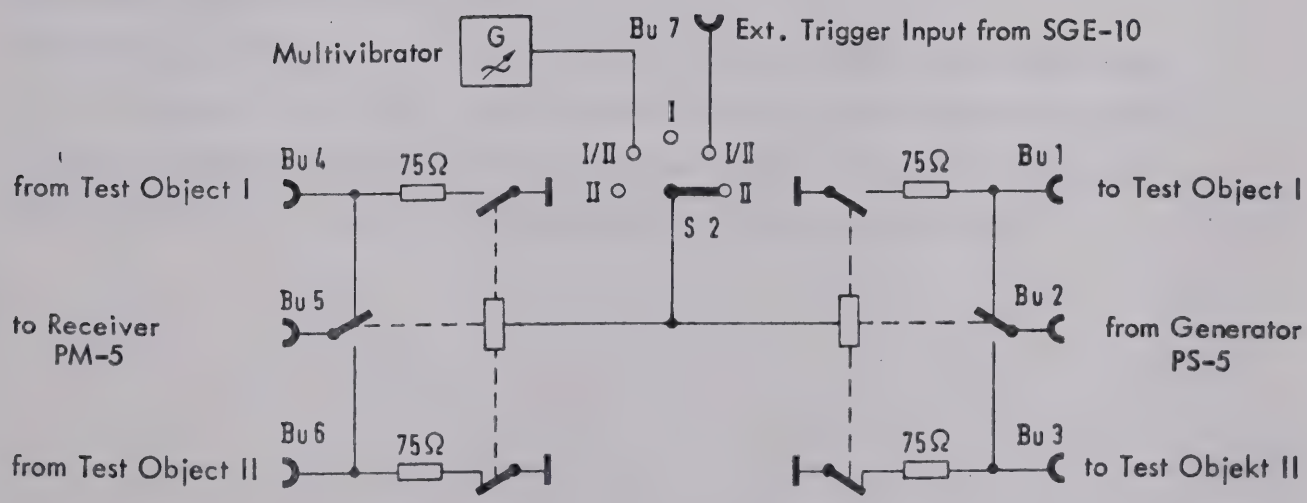

Fig. 10 RU-3 Basic Circuit Configuration

4.6. Change-Over Relay Unit RU-3

To effect economical series of measurements and alignment tasks the test object is connected via the Change-Over Relay Unit RU-3 between the generator and receiver of the sweep measuring set. In addition a reference object (for instance an accurately aligned specimen) is connected to the change-over relay. The display unit then shows alternately the test object curve and that of the reference object.

Example : Filter alignment

An aligned filter serves as a secondary standard. The filter to be aligned is inserted as the test object. The change-over relay now switches the two filters alternately into the measuring circuit.

The test object is then aligned so that both displayed curves coincide.

The change-over relay contains a flip-flop for switching the reed relays and also a multivibrator for generating the change-over pulses required by the flip-flop when switch S 2 is positioned to 'internal'.

A trigger signal is applied to socket Bu 7 of the SGE-10 which is used to operate the flip-flop in switch position 'Trigger ext.' of switch S 2. This trigger signal is the sawtooth retrace pulse itself in the operating mode 'reference line OFF' of the SGE-10 whereas it is the change-over pulse of a bistable multivibrator in the SGE-10 in the operating mode 'reference line ON'.

The change-over frequency of the multivibrator can be adjusted with potentiometer P 1 in the range 1 Hz to 50 Hz. Using the mode selector S 2 the flip-flop can be set to one of its two gated positions so that either test object I only (S 2 in position I) or test object II (S 2 in position II) is connected into the measuring circuit.

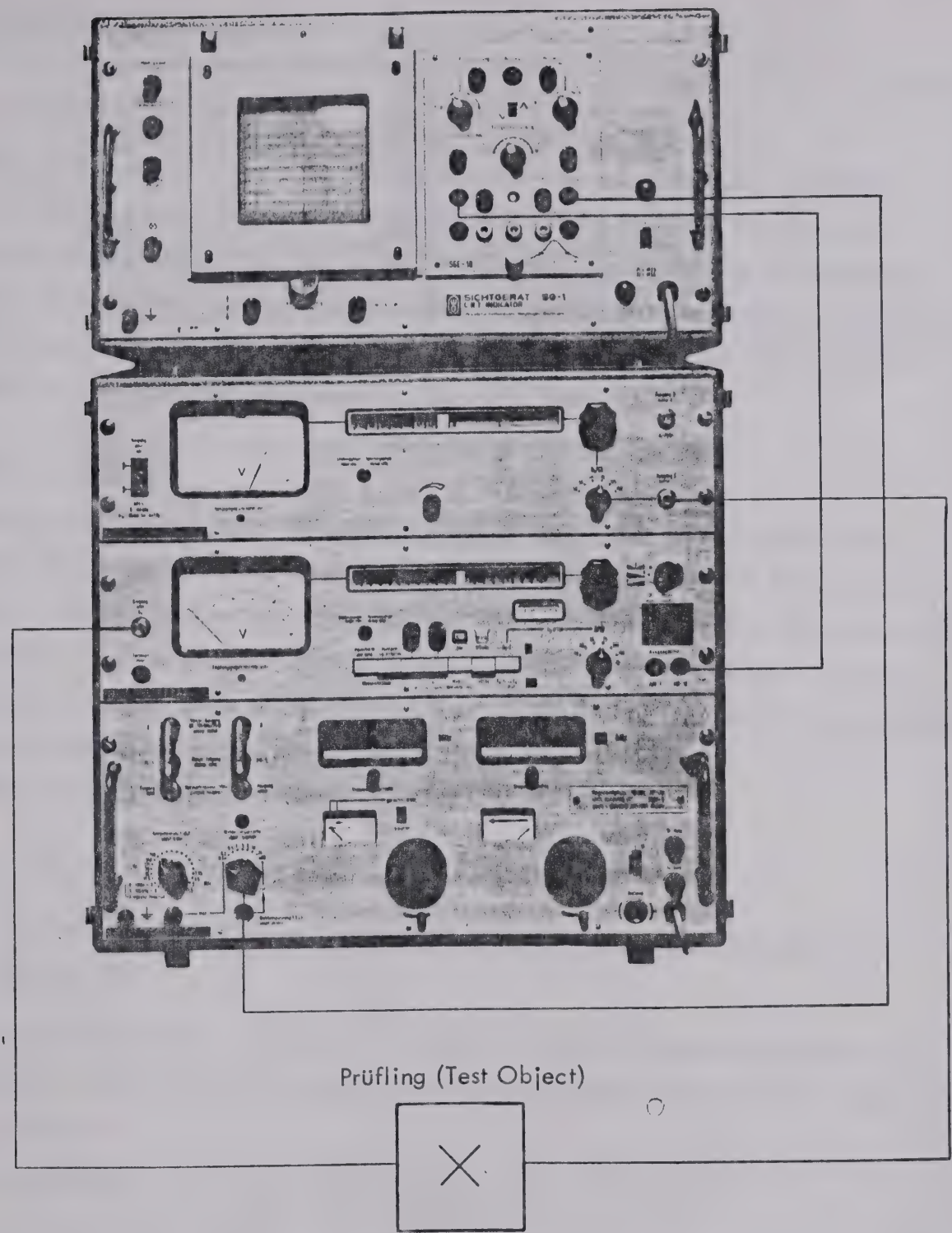

Bild 11 Wobbelmeßplatz WM-50
Zusammenschaltung PSM-5, SG-1 und SGE-10

Fig. 11 Sweep Measuring Set WM-50
Interconnection of PSM-5, SG-1 and SGE-10

5. OPERATING INSTRUCTIONS

5.1. Introductory Remarks

It is good practice to place the Display Unit SG-1 on top of the Level Measuring Set PSM-5 as shown in Fig. 11. The plastic studs on the bottom of the display unit ensure safe standing of the unit on the PSM-5. Prior to switching-on the measuring set, the individual instruments must be checked for correct mains voltage adjustment. The instruments are set on delivery for 220 V a. c. mains operation. For further details see PSM-5 Instruction Manual.

5.2. Switching On

When making initial use of the measuring set, it is advisable to first switch on the Level Measuring Set PSM-5 and then to calibrate the receiver unit in the mode 'lin' after a warm-up time of 30 seconds. Output I of the generator unit is then connected to the input of the receiver and the common operation of the two units is checked in the 'short-circuit' mode. Following this function check the Level Measuring Set PSM-5 is connected to the display unit as shown in Fig. 11.
After having switched on the instruments, proceed as follows:

5.3. Horizontal Calibration

a) Turn switch S 1601 ('Sweep Frequency') on RWO-5 to position 'external' (see Fig. 1).

b) Shift the trace with potentiometer 'Y-shift' on the SG-1 front panel so that two exactly equal trace halves result from intersection with the centre vertical graticule line.

c) Select desired sweep frequency with switch S 1601.

d) Adjust trace deflection using control P 203 ('X-amplitude') on SGE-10 so that the trace is written across the full graticule width.

5.4. Vertical Calibration

a) No signal at PM-5 input.

b) Mode Selector S 1801/1 on PM-5 in position 'low noise'.

c) Level switch S 1803 in range 'lin'.

d) Button S 1801/5 in position 'meter ON'.

The forward and return traces must appear as a single line. Should two separate lines occur, proceed as follows:

e) Remove protective cap from potentiometer P 202 on SGE-10.

f) Adjust forward trace with potentiometer P 202 to coincide with return trace.(In the expanded mode zero line adjustment must be achieved separately.)

g) Use the vertical shift control of the SG-1, to achieve coincidence of this zero line with the top graticule line in the case of attenuation measurements (S 204 in position $\vee$) resp. to coincide with the bottom graticule line for gain measurements (S 204 in position $\wedge$).

Note:

The graticule plate can be inserted as required for either attenuation measurements or gain measurements. The graticule plate is correctly mounted for attenuation (or gain) measurements when the word ATTENUATION (or GAIN) can be seen below the right-hand bottom corner of the graticule.

The sign of the dB (or Np) scale markings are valid for gain measurements only and not for attenuation measurements. For a logarithmic display a graticule having a linear graduation must be employed: this is marked 'WM-50 log'.

h) Position switch S 1801/5 of the PM-5 to 'MEASURING TRACE'.

i) Switch S 201 on SGE-10 to 'ON'
PM-5 meter then indicates the reference line (measuring line) level.

k) Adjust potentiometer P 201 ('REFERENCE LINE') until the PM-5 meter needle is opposite to the calibration marker (red triangle lin. operation or blue triangle log. operation).

l) Using potentiometer P 204 (Y-amplitude) shift the line resulting from procedure k) to coincide with the relevant graticule line indicated by the calibration triangle.

Following these adjustments, the screen is calibrated for measurements in both the logarithmic and linear range of the PM-5; i.e. it is not necessary to recalibrate on exchanging a graticule.

5.5. Measuring

After having calibrated the sweep measuring set the following adjustments are necessary:

5.5.1. Adjustments on the Oscillator Unit RWO-5

5.5.1.1. Sweep Width

Switch S 1602 permits adjustment of the sweep width, which can be selected between ± 17.5 Hz and ± 17.5 MHz depending on the bandwidth of the object under test. 19 different values of the sweep width are provided in this range. The resulting calibration of the screen X-axis (frequency difference per scale division of the graticule) can be seen from the following table:

Width:	± 17.5 Hz	= 2.5 Hz/Scale Div.	Width:	± 17.5 kHz	= 2.5 kHz/Scale Div.
	± 35 Hz	= 5 Hz/Scale Div.		± 35 kHz	= 5 kHz/Scale Div.
	± 70 Hz	= 10 Hz/Scale Div.		± 70 kHz	= 10 kHz/Scale Div.
	± 175 Hz	= 25 Hz/Scale Div.		± 175 kHz	= 25 kHz/Scale Div.
	± 350 Hz	= 50 Hz/Scale Div.		± 350 kHz	= 50 kHz/Scale Div.
	± 700 Hz	= 100 Hz/Scale Div.		± 700 kHz	= 100 kHz/Scale Div.
	± 1.75kHz	= 250 Hz/Scale Div.		± 1.75 MHz	= 250 kHz/Scale Div.
	± 3.5 kHz	= 500 Hz/Scale Div.		± 3.5 MHz	= 500 kHz/Scale Div.
	± 7 kHz	= 1 kHz/Scale Div.		± 7 MHz	= 1 MHz/Scale Div.
				± 17.5 MHz	= 2.5 MHz/Scale Div.

5.5.1.2. Centre Frequency

This adjustment is achieved in the same manner as for manual frequency adjustment of the coarse and incremental tuning oscillator, whereby the former is operated in the locked mode to avoid spurious effects. The selection of the centre frequency can be independent of the sweep width, whereby, however, the sum of the centre frequency and the sweep width can have a maximum of 36 MHz and the difference of the centre frequency and the sweep width a minimum of 10 kHz. For sweep widths up to a maximum of 1.75 kHz the incremental tuning oscillator is operative in the range -10 kHz to +100 kHz. For sweep widths of ±3.5 kHz to ± 700 kHz the incremental tuning oscil-

lator is operative in the range 'x 10' (-100 kHz to +1 MHz).

The incremental tuning oscillator is inoperative at sweep widths of 1.75 MHz to 17.5 MHz adjustment to the centre frequency being then achieved solely by the coarse tuning oscillator. The centre frequency remains constant when the change-over does not exceed the following limits during adjustment of the sweep width. The accuracy of the centre frequency is reduced as the sweep width increases. After calibration of the oscillator frequency scales the accuracy is as follows for sweep widths of:

± 17.5 Hz to ± 17.5 kHz	max. ± 3 % of adjusted sweep width
± 35 kHz to ± 700 kHz	max. ± 3 % of adjusted sweep width ± 70 kHz
± 1.75 MHz to ± 17.5 MHz	max. ± 3 % of adjusted sweep width ± 500 kHz

5.5.1.3. Sweep Frequency

The frequency range which is swept per second by the sending frequency or by the receiver tuning frequency — i.e. the so-called frequency rate of change — depends on the sweep frequency and the sweep width. The values adjusted on the RWO-5 lie in the range 3.5 Hz/s to 1.75 GHz/s. At a selected sweep width (S 1602) the frequency rate of change can be adapted to the transient behaviour of the object under test with the aid of switch S 1601 (SWEEP FREQUENCY). Optimum adaptation is achieved when no or very little distortion in the sweep trace is to be observed upon increasing the sweep frequency by one step with S 1601. With the Scale Expander AZD-1 connected, the button S 1801/5 on the PM-5 front panel must be positioned to 'MEASURING TRACE' thus avoiding an increase of the receiver transient period.

Direct adjustment of the sweep frequency between 0.1 Hz and 50 Hz is provided. The sweep frequency can be further reduced by inserting an additional capacitor of corresponding value across contact 4 and ground contact 3 of socket Bu 1601 ('SWEEP VOLTAGE'), whereby the sweep frequency selector S 1601 must be positioned to '50 Hz'. For capacitance values of 15,30 and 75 µF for instance the sweep frequency is approx. 0.1, 0.05 or 0.02 Hz respectively. The upper limit of the capacitance value is determined by the leakage current, which should not exceed 2 µA.

5.5.1.4. External Sweep Voltage Facility

After having positioned the sweep frequency selector S 1601 to 'ext', an external sweep voltage of arbitrary waveform can be applied to socket Bu 1601 between contact 5

and ground contact 3. The external sweep voltage should lie symmetrical about the zero line and should not considerably exceed ± 3.5 V. For a voltage of ± 3.5 V the sweep width corresponds to the value selected with the sweep width selector. Input impedance is approx. 10 kΩ.

5.5.1.5. Manual Sweep

When the sweep frequency selector S 1601 is positioned to 'man.', frequency adjustment can be achieved manually with potentiometer P 1601. This operating mode is especially useful when a measuring curve requires repeated random sweeping, e.g. during alignment.

5.5.2. Adjustments to the Generator Unit PS-5

Set output level at output I using coarse attenuator S 901 and fine attenuator P 1002.
Use selector S 902 to match generator output impedance to test object input impedance.
Select reference level with switch S 1001.

5.5.3. Adjustments to the Receiver Unit PM-5

The adjustments to the receiver are as follows:
Set receive level with attenuator S 1803
Depress button S 1801/7 to select 'low noise' mode
Select input impedance with Z selector S 101 and button S 1801/7
Switch meter to 'MEASURING TRACE' with button S 1801/5
Select bandwidth with button S 1801/6
Select reference level with switch S 1802

5.5.4. Adjustments to the Display Plug-In Unit SGE-10

Select Y-inversion with switch S 204 for attenuation or gain
Set Y-expansion with switch S 203
Adjust Y-shift with control P 205
Select reference line with S 201
Adjust ref. line shift with potentiometer P 201

5.5.4.1. X-Reversal

The display plug-in unit is normally adjusted to trace an increase in frequency from left to right across the screen. This can be reversed to effect right to left tracing by switching S 202 to position 1. This switch is located on the rear of the plug-in and is thus accessible only after removing the plug-in from the basic unit.

5.5.4.2. Measuring Sequence

The measuring curve is displayed during the forward trace of the sawtooth voltage. During retrace, which is about 5 times faster, the signal voltage is switched off and the zero line injected. This results in the following measuring sequence:

Without Change-Over Relay

for 'ref. line off': object, zero line, object, zero line ...

for 'ref. line on': object, zero line, ref. line, zero line, object...

With Change-Over Relay

for 'ref. line off': object I, zero line, object II, zero line, object I...

for 'ref. line on': object I, zero line, ref. line, zero line, object II, zero line, ref. line, zero line, object I...

5.5.4.3. Y-Expansion x 2, x 5, x 10

In the expanded mode zero line calibration must be repeated as described under 5.4. To effect expansion of the display in the Y-direction, the switch S 203 ('Y-expansion') is positioned accordingly. The result can be expanded by factors of 2, 5 or 10. Using control P 205 ('Y-shift') the trace is shifted vertically as desired thus enabling any portion of an attenuation curve to be observed greatly expanded.

Using the factor 10, changes in attenuation of 1 % can be displayed as a Y-deflection of 1 cm.

5.5.4.4. Reference Line

In the position 'ON' of switch S 201 a reference line is injected into the display. The position of this line can be adjusted with potentiometer P 201 ('REF. LINE') and shifted to cut or touch an attenuation or gain characteristic at any desired point. When the button S 1801/5 of PM-5 is set to 'MEASURING TRACE' (reference line), the reference line level can be read-off from the PM-5 meter thus considerably reducing

errors due to scale division inaccuracies and parallax in comparison with that occurring when reading the level directly from the screen. For very small attenuation differences of the test object and with the Y-expansion operative, the accuracy of the reading can be enhanced by connecting the scale expander AZD-1 to the PM-5, since the reference line level is also displayed on the AZD-1 in the position 'MEASURING TRACE' (reference line) of button S 1801/5.

5.5.4.5. X-Y-Output

The deflection signals are available at socket Bu 205 ('OUTPUT') for further use in a recorder or large screen display unit. The Y-signal is available across contacts 1 and 2, the X-signal across contacts 4 and 5.

Connections of socket Bu 205 ('OUTPUT')

Y-signal

In position ∨ of S 204 contact 2 is grounded

In position ∧ of S 204 contact 1 is grounded

X-signal

In position 1 of S 202 contact 5 is grounded

In position 2 of S 202 contact 4 is grounded

The pulse modulated a.c. voltage of the frequency marker generator is not switched: it is always present at contact 3.

Contact numbering of socket Bu 205 ('OUTPUT')

viewed on the front panel

(The sockets Bu 201, 203, 204 have the same numbering)

The signals are referred to ground. Signal inversion is achieved with the respective switches for X or Y polarity changing (S 202 and S 204). Internal resistance and output voltage are contained in the specifications for SGE-10 (see 1.2.4.). At contact 3 of socket Bu 205 the a.c. pulse of the marker generator oscillator is available.

5.5.4.6. Socket Bu 204 'SWEEP VOLTAGE'

Socket Bu 204 is connected in parallel with socket Bu 203 'X-input'. The latter is connected to the socket Bu 1601 ('SWEEP VOLTAGE') of RWO-5 via a 5-core lead. In this case the sweep voltage socket Bu 204 of SGE-10 assumes the task of Bu 1601 on RWO-5, thus providing an input or output for control signals.

5.6. Frequency Markers

Frequency markers can be injected into the sweep display with the aid of an external frequency marker generator. These markers result when the signal frequency is equal to the marker frequency or to one of its harmonics. The markers can be established on the signal trace or the reference line. The use of a second generator of a corresponding lower frequency, enables sideband markers to be generated in association with the main markers.

The beat-frequency markers are generated in a mixer and their width is adjusted in the succeeding switchable low-pass filter (S 401 'FREQUENCY MARKER WIDTH'). They then display the known form:

When using very narrow frequency markers, the marker amplitude will vary according to the accidental phase of the measuring and reference voltage at the moment of frequency coincidence. Such amplitude-fluctuating and relatively wide beat-markers are, in most cases, unsuitable. For this reason the difference frequency oscillation obtained from the mixer is given to a trigger circuit in the SGE-10. The trigger is operated on reaching an adjustable threshold (P 301) thus switching-in an astable multivibrator, whose AC pulse represents the actual frequency marker.

The frequency marker generator must, of course, deliver a frequency of sufficient accuracy and stability, otherwise the marker is difficult to locate at relatively low sweep widths or drifts out of the display during the measuring process. The standard frequency voltage of the RWO-5 (available at socket Bu 1303) is well suited for generating the frequency markers at integral multiples of 1 MHz. By inserting a frequency divider (for instance the DFT-1 of Wandel u.Goltermann) a crystal-accurate marker voltage of lower frequency is achieved.

Frequency marker adjustment is facilitated by first displaying merely a horizontal line, the test object being placed out of circuit. The subsequent insertion of the test object

has no effect on the marker resolution.

5.6.1. Frequency Markers without Sideband Markers

'Output II' of the generator PS-5 is connected to input 'f_1' of SGE-10. The marker frequency is applied at input 'f_2'. The required input voltages are for sinusoidal or square waveforms U_{peak} = 0.3 V to 10 V. Potentiometer P 302 ('AMP.') is turned to its central position.

Fig. 12 shows the relation between sweep width, sweep frequency and min. adjustable marker width. This diagram is indispensable for fast and correct adjustment of the frequency markers. (A further diagram is included in the appendix). Direct sweep frequency adjustment on the PSM-5, within the dashed line range shown in the diagram, is not possible. For this purpose the sweep frequency must either be reduced by inserting additional capacitors or the sweep voltage must be applied externally. See 5.5.1.3. and 5.5.1.4.

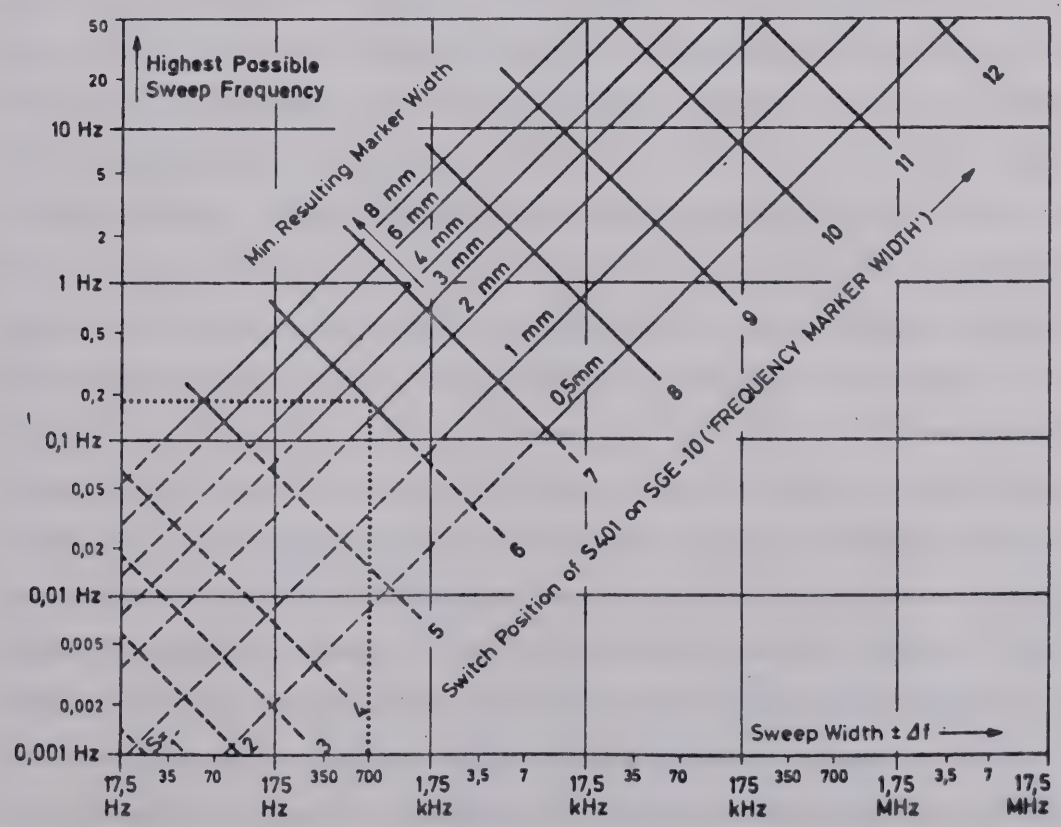

Fig. 12 Setting-Up Procedure of the Frequency Markers

and a sweep frequency of approx. 10 Hz.

At low sweep frequencies (below 1 Hz) the trigger adjustment is difficult to achieve. In this respect it is good practice to position switch S 1601 ('SWEEP FREQU.') on RWO-5 to 'MANUAL' and to carry out manual deflection using potentiometer P 1601. Once the frequency markers are located, the trigger threshold can be satisfactorily adjusted. Subsequent change-over to automatic sweeping seldom requires re-adjustment to the trigger threshold.

Finally the desired marker amplitude can be adjusted with potentiometer P 302 ('AMP.').

5.6.2. Sideband Markers

Main or centre frequency marker adjustment is effected as described in the previous section. In addition the frequency of the sideband marker generator is applied to input 'f_3' of the SGE-10. The centre frequency is then formed by the marker frequency. The sideband frequency should be considerably smaller than the marker frequency to avoid any of the interference lines resulting from the mixer products $2 f_2 \pm f_3$ occuring within the band of interest. When the main marker and the sideband markers are respectively located at the centre and near the edge of the display area, no interference markers $n \cdot f_3$ are displayed, which would, without this, tend to appear in a irregular manner. Normally the sideband markers appear whereas the main marker disappears, it is thus usually necessary to slightly change the trigger threshold to effect regular recurrence of the markers. At a sideband frequency voltage of approx. 1.5 V, centre markers and sideband markers often occur simultaneously (especially at low frequencies). This adjustment is, however, unstable and not to be recommended, otherwise the sweep frequency would require reduction and also marker triggering would fail to occur during each sweep period. Some further sideband markers appear in addition to the desired markers, so that it is difficult to determine which frequency marker represents the centre frequency. At the given marker voltage of 2 to 5 V one obtains only the sideband markers but the location of the centre frequency marker is facilitated by simply disconnecting the sideband marker voltage.

The connection of a marker generator with modulation facilities across input 'f_2' of the SGE-10 permits simultaneous display of centre and sideband markers, whereby the spacing of the latter from the former corresponds to the relative modulation frequency.

5.7. Change-Over Relay Unit RU-3

5.7.1. Putting into Operation

The connection of the RU-3 to the WM-50 and to the test objects is illustrated in Fig. 13. Following mains connection, the RU-3 is switched on with control P 1/S 1 (see Fig. 9). Mains ON is indicated by the pilot lamp SL1.

5.7.2. Manual Change-Over Mode

The switch S 2 ('CHANGE-OVER') is positioned to 'I' or 'II', whereby only the relative test object is switched into circuit. This operating mode is selected for measurements on a single test object only, or when occasional switching from one test object to the other is desired. The switch position 'II' is duplicated so that in both of the positions for automatic change-over 'I/II' only one switching step either to the left or to the right is necessary to switch into circuit one test object alone.

5.7.3. Change-Over with Internal Change-Over Frequency

Switch S 2 'CHANGE-OVER' is positioned to 'I/II INTERN'. The change-over between the two test objects is effected by a built-in multivibrator. The change-over frequency is adjusted with potentiometer P 1 ('FREQ. INTERN'); adjustment range being 1 Hz to 30 Hz. This mode is selected when change-over between two test objects is desired both independent from the sweep frequency and also at a fixed frequency.

When interpreting the resulting display the transient time of the test object following change-over must be taken into consideration.

5.7.4. Change-Over with External Trigger Facility

Switch S 2 ('CHANGE-OVER') is positioned to 'I/II TRIGG. EXT'. Change-over between the two test objects is now effected in sychronism with the sweep frequency of the PSM-5. The retrace pulse from the RWO-5 turns off the RU-3 during the sawtooth retrace interval. The attenuation curves of both test objects are fully displayed successively. In the mode 'REF. LINE ON' of the SGE-10 the reference line is injected each time between the two test object curves resulting in the following sequence:

Example:	(see Fig. 12, dotted lines)
Given:	centre frequency = 1 MHz sweep width = ± 700 Hz
selected:	marker frequency = 1 MHz
required:	switch position of S 401 on SGE-10 ('FREQUENCY MARKER WIDTH') sweep frequency

The vertical $\pm \Delta f$ = 700 Hz cuts all of the inclined lines for the switch positions S = 1 to 7. The min. marker width resulting is given by the corresponding vertical lines.

S = 1, 2, 3 and 4 are of no practical significance in the present example since the points of intersection devote marker widths of values less than 0.5 mm (i.e. minimum possible marker width).

The switch position S = 5 still remains within the dashed range. The low sweep frequency of 0.02 Hz required by the diagram cannot be adjusted directly on PSM-5 and if needed, one of the procedures described under 5.5.1.3. and 5.5.1.4. must be carried out.

Switch position S = 6 results in an adjustable sweep frequency of 0.2 Hz on the PSM-5 at a marker width of 2 to 3 mm. This is the optimum adjustment for the present example.On the other hand, the switch position S = 7 results in a relatively large frequency marker width of 6 to 8 mm.

Should the sweep frequency derived from the diagram occur between two adjustable frequency values, the smaller sweep frequency should be preferred to ensure definite triggering of the markers.

Turning the Potentiometer P 301 ('THRESHOLD') clockwise results in the response sensitivity of the marker generator being increased until triggering occurs. This potentiometer also enables the marker width to be adjusted within certain limits. Excessive marker width can be reduced with P 301 accompanied by a reduction of the marker width response sensitivity as long as constant marker triggering occurs. Minimum marker width as derived from the diagram Fig. 12 is thus achieved.

A larger marker width can be selected as desired with the aid of the trigger threshold, so that frequency markers can be injected into the display even in the range below the '0.5 mm line'.

At a sweep-width e.g. of ± 7 or ± 17.5 MHz one should select switch position S = 12

5.7. Change-Over Relay Unit RU-3

5.7.1. Putting into Operation

The connection of the RU-3 to the WM-50 and to the test objects is illustrated in Fig. 13. Following mains connection, the RU-3 is switched on with control P 1/S 1 (see Fig. 9). Mains ON is indicated by the pilot lamp SL1.

5.7.2. Manual Change-Over Mode

The switch S 2 ('CHANGE-OVER') is positioned to 'I' or 'II', whereby only the relative test object is switched into circuit. This operating mode is selected for measurements on a single test object only, or when occasional switching from one test object to the other is desired. The switch position 'II' is duplicated so that in both of the positions for automatic change-over 'I/II' only one switching step either to the left or to the right is necessary to switch into circuit one test object alone.

5.7.3. Change-Over with Internal Change-Over Frequency

Switch S 2 'CHANGE-OVER' is positioned to 'I/II INTERN'. The change-over between the two test objects is effected by a built-in multivibrator. The change-over frequency is adjusted with potentiometer P 1 ('FREQ. INTERN'); adjustment range being 1 Hz to 30 Hz. This mode is selected when change-over between two test objects is desired both independent from the sweep frequency and also at a fixed frequency.

When interpreting the resulting display the transient time of the test object following change-over must be taken into consideration.

5.7.4. Change-Over with External Trigger Facility

Switch S 2 ('CHANGE-OVER') is positioned to 'I/II TRIGG. EXT'. Change-over between the two test objects is now effected in sychronism with the sweep frequency of the PSM-5. The retrace pulse from the RWO-5 turns off the RU-3 during the sawtooth retrace interval. The attenuation curves of both test objects are fully displayed successively. In the mode 'REF. LINE ON' of the SGE-10 the reference line is injected each time between the two test object curves resulting in the following sequence:

test object I, reference line, test object II, reference line, test object I etc.....

This mode of operation is designed especially for alignment work. The first object is then the object requiring alignment, whilst the second, for instance an exactly aligned object, serves as a standard.

Calibrated attenuators, etc. can also be used as standards. In reference measurements of this type the instrinsic errors of the measuring set have no effect on the measurement.

5.8. Further Accessories

(for more details see PSM-5 instruction manual)

The Scale Expander AZD-1 provided as a PSM-5 accessory for the measurement of small level variations as described under 4.5.3. can also be used in conjunction with the WM-50 for accurately determining the SGE-10 reference line level.

The Probe TK-8 finds application where low capacitance, high impedance measurements are to be carried out on a test object. The TK-8 is connected to the Receiver PM-5 from which it also receives its operating voltage.

The Return Loss Measuring Accessory RFZ-5 when used together with the sweep measuring set enables the return loss of a test object to be swept and referred to standards. Fig. 14 shows the connection of this accessory to the sweep measuring set. The leads connecting the PSM-5 are matched to 75Ω, thus enabling the RFZ-5 to be connected by cables and located in the close vicinity of the test object. This accessory operates on the principle of the Wheatstone bridge. At low frequencies the bridge is balanced purely resistive; at high frequencies additional capacitive balancing is to be carried out.

Functional and operational details of the above mentioned accessories are contained in the PSM-5 instruction manual.

The cabinet SGEG-1 for the Display Plug-In Unit SGE-10 contains a mains transformer and finds application when a display instrument other than the SG-1 is used (e.g. oscilloscope, large screen display unit, X-Y plotter, etc.), whereby the functions of the SGE-10 such as X and Y-inversion, Y-expansion, injection of reference lines and frequency markers are retained.

6. GRATICULE PLATES

Included in the standard accessories of the sweep measuring set are 2 graticule plates, WM-50 dB for dB instrument version (resp. WM-50 Np for Np instrument version) and WM-50 log. The former (dB resp. Np instrument version) has a logarithmic ruling with respect to the attenuation and gain scale and is used in the linear mode of the WM-50; in this mode a level range of approx. 20 dB (resp. 3 Np) is covered.

To display attenuation values the graticule plate is correctly mounted, when the word 'ATTENUATION' can be read below the bottom right-hand corner of the graticule. The zero line in this case must be established coincident with the uppermost graticule line. For gain measurement, the graticule plate must be inserted so that the word 'GAIN' can be read below the bottom right-hand corner of the graticule. In this case the zero line must be established coincident with the bottom graticule line.

For large level differences up to 100 dB (resp. 10 Np) the measuring set is operated in the logarithmic mode. Use is then made of the graticule plate WM-50 log which has linear ruling along the Y-axis and can be used for both the dB and Np versions of the sweep measuring set.

When mounting the graticule plate, note that the engraved side of the graticule plate must be faced to the screen of the display unit thus keeping errors due to parallax to a minimum.

The graticule plates are illustrated on the following pages (Figs. 15, 16 and 17).

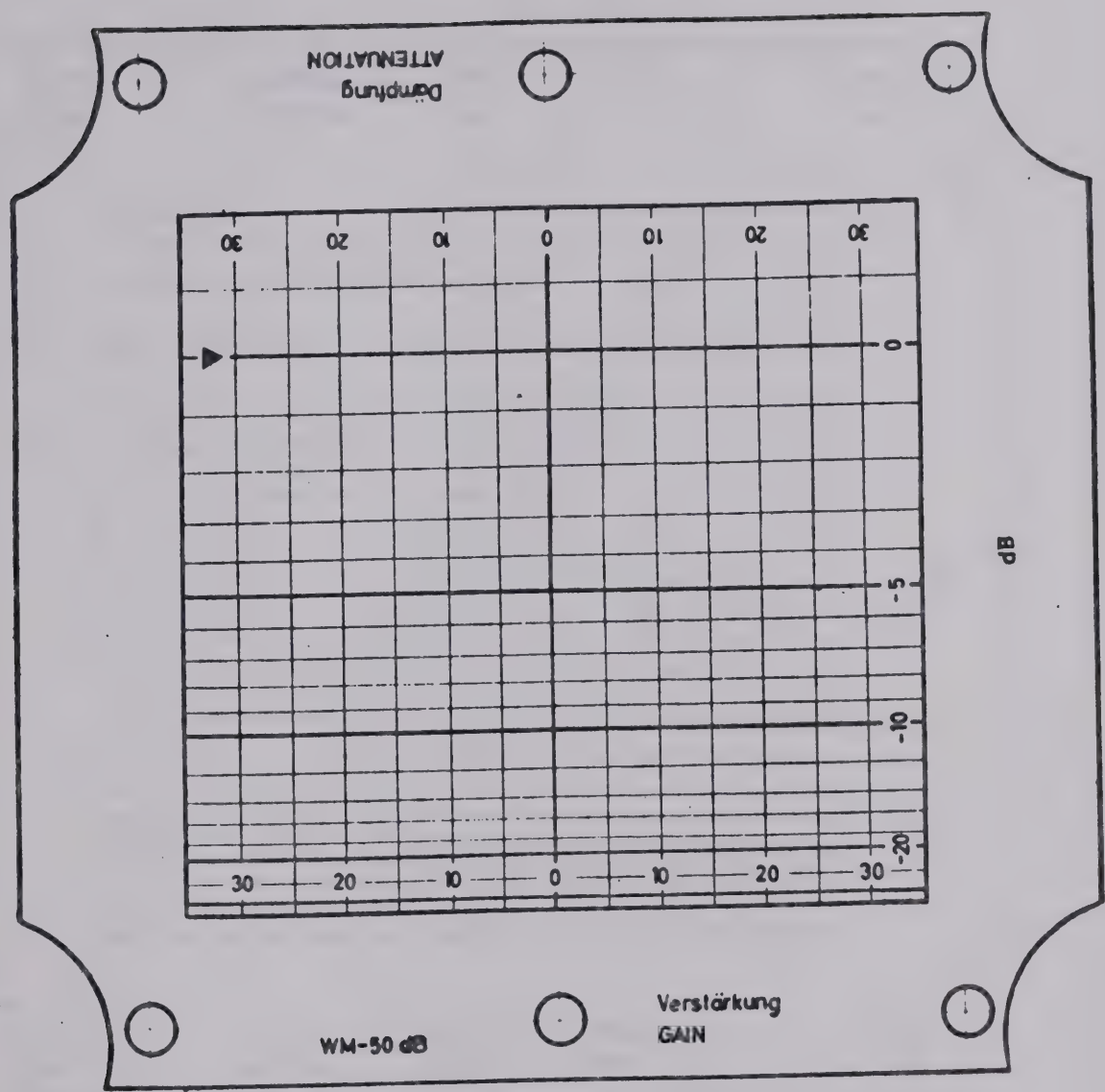

Bild 15 Rasterscheibe WM-50 dB

Fig. 15 Graticule Plate WM-50 dB

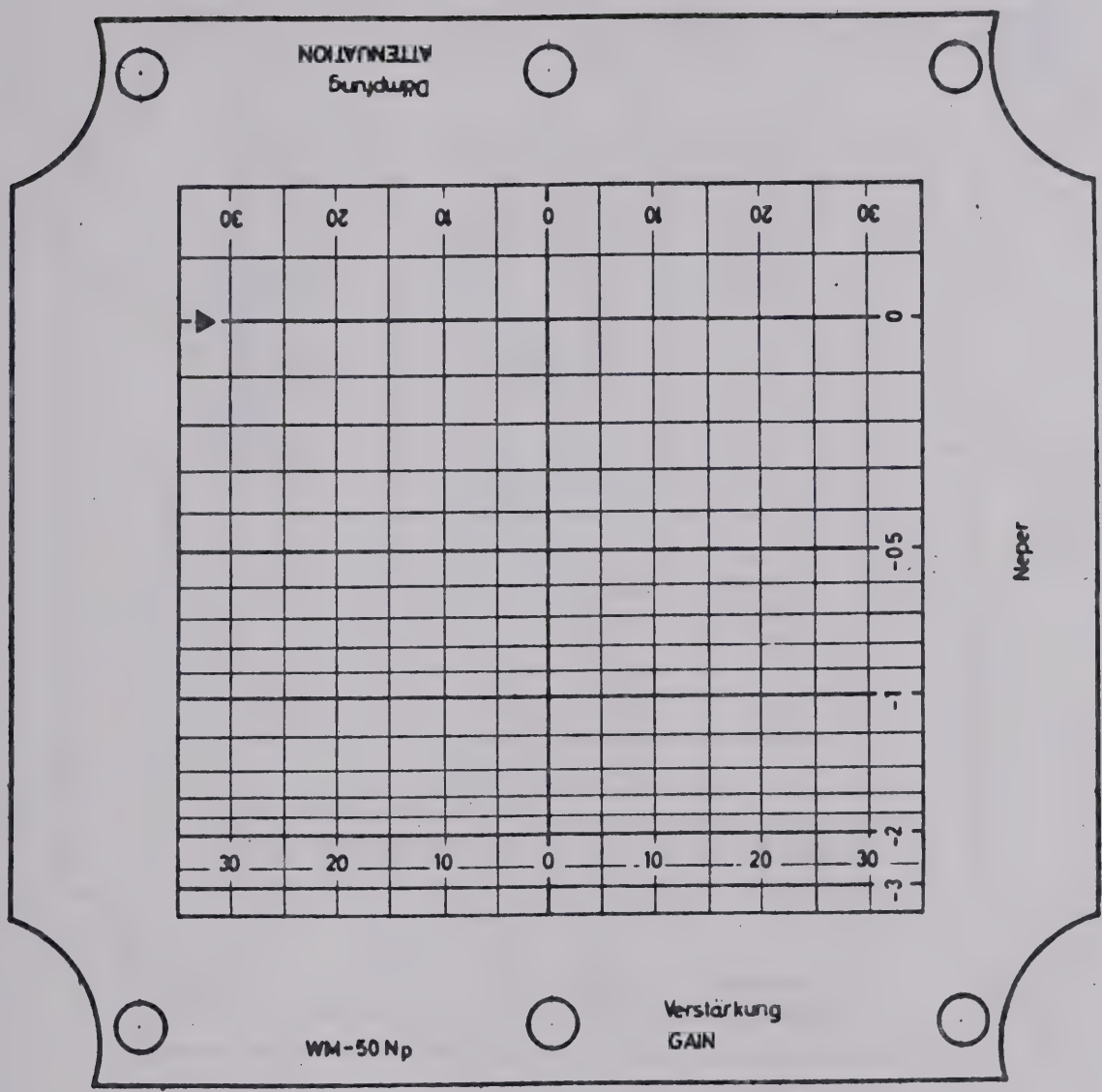

Bild 16 Rasterscheibe WM-50 Np

Fig. 16 Graticule Plate WM-50 Np

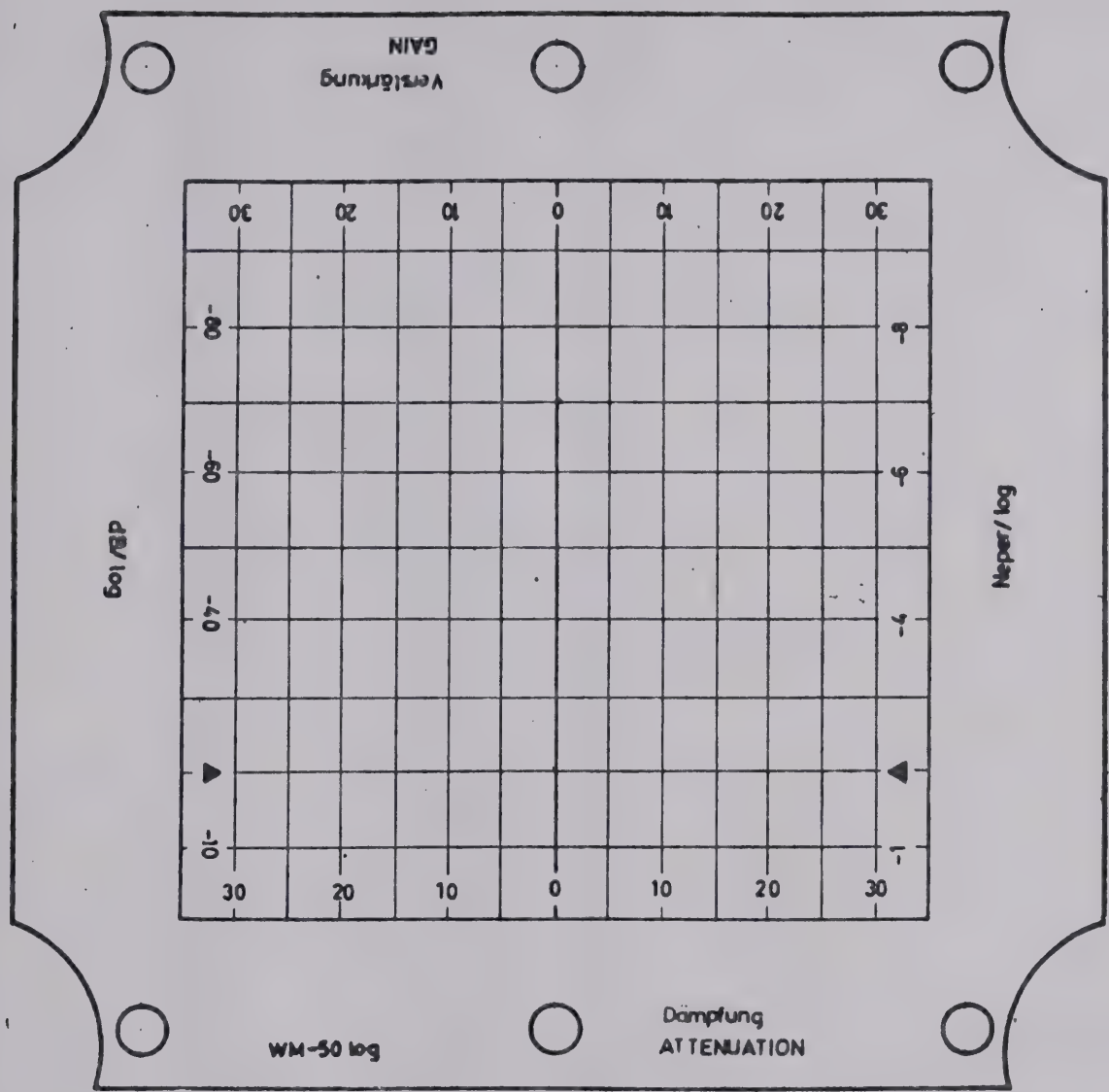

Bild 17 Rasterscheibe WM-50 log

Fig. 17 Graticule Plate WM-50 log

Y-Verstärker (Y-Amplifier)

Widerstände (Resistors)

R 201	1 kΩ	0,25 W	5 %	
R 202	10 kΩ	0,33 W	0,5 %	
R 203	5,6 kΩ	0,25 W	1 %	TK 50 MLAD
R 204	1 kΩ	0,25 W	5 %	
R 205	220 kΩ	0,25 W	5 %	
R 206	4,7 kΩ	0,25 W	5 %	
R 207	33 kΩ	0,25 W	5 %	
R 208	6,8 kΩ	0,25 W	5 %	
R 209	1 MΩ	0,25 W	5 %	
R 210	10 kΩ	0,25 W	5 %	
R 211	15 kΩ	0,25 W	5 %	
R 212	82 kΩ	0,25 W	5 %	
R 213	1 kΩ	0,25 W	5 %	
R 214	6,8 kΩ	0,25 W	5 %	
R 215	82 kΩ	0,25 W	5 %	
R 216	15 kΩ	0,25 W	5 %	
R 217, 218	22 kΩ	0,25 W	5 %	
R 219	3,3 kΩ	0,25 W	5 %	
R 220	27 kΩ	0,25 W	5 %	
R 221	100 Ω	0,25 W	5 %	
R 222	12 kΩ	0,25 W	5 %	
R 223	6,8 kΩ	0,25 W	5 %	
R 224	100 kΩ	0,25 W	5 %	
R 225	33 kΩ	0,25 W	5 %	
R 226	1 kΩ	0,25 W	5 %	
R 227	10 kΩ	0,25 W	5 %	
R 228	1 kΩ	0,25 W	5 %	
R 229	100 kΩ	0,25 W	5 %	
R 230	1 kΩ	0,25 W	5 %	
R 231	18 kΩ	0,25 W	5 %	
R 232	100 kΩ	0,25 W	5 %	
R 233	8,2 kΩ	0,25 W	1 %	TK 50 MLAD
R 234	1,8 kΩ	0,25 W	5 %	
R 236	470 kΩ	0,25 W	5 %	
R 237	82 kΩ	0,25 W	5 %	
R 238, 239	10 kΩ	0,33 W	0,5 %	
R 240	1,8 kΩ	0,25 W	5 %	
R 241	22 kΩ	0,25 W	5 %	
R 242	80 kΩ	0,33 W	0,5 %	
R 243	100 Ω	0,25 W	5 %	
R 244	3,9 kΩ	0,25 W	5 %	
R 245	48 kΩ	0,33 W	0,5 %	
R 246	12 kΩ	0,25 W	1 %	TK 50 MLAD
R 247, 248	100 kΩ	0,25 W	5 %	

Frequenzmarkengeber HF-Teil (Frequency Marker Generator)

Widerstände (Resistors)

R 401	82 Ω	1,4 W	5 %	RIG
R 402	150 Ω	1 W	5 %	
R 403	82 Ω	1,4 W	5 %	RIG
R 404	1,5 kΩ	0,25 W	5 %	
R 405	3,3 kΩ	0,25 W	5 %	
R 406	150 Ω	1 W	5 %	
R 407	330 Ω	0,25 W	5 %	
R 408	47 Ω	0,25 W	5 %	
R 409	330 Ω	0,25 W	5 %	
R 410, 411	47 Ω	0,25 W	5 %	
R 412	3,3 kΩ	0,25 W	5 %	
R 413	1,5 kΩ	0,25 W	5 %	
R 414, 415	150 Ω	1 W	5 %	
R 416	47 Ω	0,25 W	5 %	
R 417	2,2 kΩ	0,25 W	5 %	
R 418	820 Ω	0,25 W	5 %	
R 419	1 kΩ	0,25 W	5 %	
R 420	1,2 kΩ	0,25 W	5 %	
R 421	100 Ω	0,25 W	5 %	
R 422	270 Ω	0,25 W	5 %	
R 423	150 Ω	0,25 W	5 %	
R 424	56 kΩ	0,25 W	5 %	
R 425	33 Ω	0,25 W	5 %	
R 426	680 Ω	0,25 W	5 %	
R 427	820 Ω	0,25 W	5 %	
R 428	10 Ω	0,25 W	5 %	
R 429	56 kΩ	0,25 W	5 %	
R 430	220 kΩ	0,25 W	5 %	
R 431	1 kΩ	0,25 W	5 %	
R 432	470 kΩ	0,25 W	5 %	

Potentiometer

P 401	250 Ω lin	0,8 W [1]
P 402	100 kΩ lin	1 W

Kondensatoren (Capacitors)

C 401	1 µF	63 V	20 %	Kunst.-Folie (plastic foil)
C 402...404	10 µF	63 V	20 %	Kunst.-Folie (plastic foil)
C 405	100 pF	160 V	2 %	Kunst.-Folie (plastic foil)
C 406	330 pF	160 V	2 %	Kunst.-Folie (plastic foil)
C 407	1 nF	400 V	10 %	Kunst.-Folie (plastic foil)
C 408	3,3 nF	400 V	10 %	Kunst.-Folie (plastic foil)
C 409	10 nF	400 V	10 %	Kunst.-Folie (plastic foil)

1) Serie (Series) KL: 200 Ω

Frequenzmarkengeber NF-Teil (Frequency Marker Generator)

Widerstände (Resistors)

R 301, 302	1 kΩ	0,25 W	5 %
R 303	100 kΩ	0,25 W	5 %
R 304	1,5 kΩ	0,25 W	5 %
R 305	100 kΩ	0,25 W	5 %
R 306	1 MΩ	0,25 W	5 %
R 307	1,8 kΩ	0,25 W	5 %
R 308	180 kΩ	0,25 W	5 %
R 309...311	10 kΩ	0,25 W	5 %
R 312	2,2 kΩ	0,25 W	5 %
R 313	5,6 kΩ	0,25 W	5 %
R 314	3,3 kΩ	0,25 W	5 %
R 315, 316	10 kΩ	0,25 W	5 %
R 317	27 kΩ	0,25 W	5 %
R 318	6,8 kΩ	0,25 W	5 %
R 319	3,3 kΩ	0,25 W	5 %
R 320	6,8 kΩ	0,25 W	5 %
R 321	3,3 kΩ	0,25 W	5 %
R 322, 323	10 kΩ	0,25 W	5 %

Potentiometer

P 301	10 kΩ lin	3 WN 17/2/5
P 302	1 kΩ lin	3 WN 17/2/5

Kondensatoren (Capacitors)

C 301	1 µF	100 V	10 %	Kunst.-Folie (plastic foil)
C 302	0,47 µF	100 V	10 %	Kunst.-Folie (plastic foil)
C 303	0,22 µF	100 V	10 %	Kunst.-Folie (plastic foil)
C 304	0,15 µF	100 V	10 %	Kunst.-Folie (plastic foil)
C 305	47 nF	125 V	10 %	Kunst.-Folie (plastic foil)
C 306	27 nF	125 V	10 %	Kunst.-Folie (plastic foil)
C 307	10 nF	400 V	10 %	Kunst.-Folie (plastic foil)
C 308	4,7 nF	400 V	10 %	Kunst.-Folie (plastic foil)
C 309	3,3 nF	400 V	10 %	Kunst.-Folie (plastic foil)
C 310	1 nF	400 V	10 %	Kunst.-Folie (plastic foil)
C 311	470 pF	160 V	± 2,5 %	Kunst.-Folie (plastic foil)
C 312	220 pF	160 V	± 2,5 %	Kunst.-Folie (plastic foil)
C 313	10 nF	125 V	10 %	Kunst.-Folie (plastic foil)

Diode

GI 301	ZP 6,8	ITT

Widerstände (Resistors)

R 1	15 kΩ	0,25 W	5 %	
R 2, 3	82 kΩ	0,25 W	5 %	
R 4	15 kΩ	0,25 W	5 %	
R 5	390 Ω	2 W	5 %	
R 6	1 kΩ	0,25 W	5 %	
R 7, 8	3,9 kΩ	0,25 W	5 %	
R 9	10 kΩ	0,25 W	5 %	
R 10	3,3 kΩ	0,25 W	5 %	
R 11, 12	2,2 kΩ	0,25 W	5 %	
R 13	3,9 kΩ	0,25 W	5 %	
R 14...17	68 Ω	0,25 W	5 %	ungewendelt (non-helical)
R 18, 19	1 MΩ	0,25 W	5 %	
R 20...23	1,2 kΩ	0,25 W	5 %	
R 24	10 kΩ	0,25 W	5 %	
R 25	47 kΩ	0,25 W	5 %	
R 26, 27	820 Ω	0,25 W	5 %	
R 28	470 Ω	0,25 W	5 % 1)	

Potentiometer

P 1	500 kΩ neg. log	0,15 W

Kondensatoren (Capacitors)

C 1	10 nF	500 V	-20/+ 50 %	Keram.
C 2	2,2 nF	500 V	-20/+ 50 %	Keram.
C 3	10 nF	500 V	-20/+ 50 %	Keram.
C 4	25 µF	70 V	-20/+ 50 %	Elko
C 5	50 µF	35 V	-20/+ 50 %	Elko
C 6	10 µF	35 V	-20/+ 50 %	Elko
C 7	3,3 µF	63 V	20 %	Kunst.-Folie (plastic foil)
C 8, 9	10 nF	500 V	-20/+ 50 %	Keram.
C 10...13	2,2 nF	500 V	-20/+ 80 %	Keram.

Transistoren (Transistors)

T 1, 4	BSY 56	ITT
T 2, 3	2 N 930/BFX 93 2)	SGS
T 5, 6	2 N 708/BSX 88	SGS

Dioden (Diodes)

Gl 1	OA 130	Telefunken
Gl 2	ZP 22 3)	ITT
Gl 3	AAZ 13	Valvo
Gl 4, 5	BA 110	ITT
Gl 6...9	OA 182	Telefunken

Serie (Series) F: 1) entfällt (deleted)
2) 2 N 708/BSX 88
3) Z 22

Gültig ab Serie I (Valid from series I)

SCHALTTEILLISTE (Parts List) 1 SGE-10/BN 322

Netzteil (Power Supply)

Kondensatoren (Capacitors)

C 101, 102	500 µF	35/40 V	Elko

Dioden (Diodes)

Gl 101...108	OA 182	Telefunken

Übertrager (Transformer)

Ü 101	Bv. 322 - 7703

2 x 18-V-Regler (Stabilizer) BN 427/21

bestehend aus (consisting of):

Widerstände (Resistors)

R 301	820 Ω	0309	5 %	Kl 2
R 302	100 kΩ	0309	5 %	Kl 2
R 303	180 Ω	0309	5 %	Kl 2
R 304	18 kΩ	0309	5 %	Kl 2
R 305	10 Ω	0309	5 %	Kl 2
R 306	10 kΩ	0309	5 %	Kl 2
R 307	270 Ω	0309	5 %	Kl 2
R 308	8,2 kΩ	0309	5 %	Kl 2
R 309	5,1 Ω		5 %	Kl 2
R 310	3,3 kΩ	0309	5 %	Kl 2
R 311	2,2 kΩ	0309	5 %	Kl 2
R 312	3,3 kΩ	0309	5 %	Kl 2
R 313	1,2 kΩ	0309	5 %	Kl 2
R 314	0,33 Ω	1 W	10 %	
R 315	47 Ω	0309	5 %	Kl 2

Potentiometer

P 301	500 Ω lin	0,8 W

Kondensatoren (Capacitors)

C 301	68 pF	500 V	2 %	Keram.	
C 302	22 nF	400 V	20 %	Kunst.-Folie (plastic foil)	
C 303	25 µF	15 V	+50 -20 %		Elko
C 304	100 µF	35 V	+50 -20 %		Elko

Dioden (Diodes)

Gl 301	1 N 4448	Cosem
Gl 302	ZP 5,1 rot (red)	

Transistoren (Transistors)

T 301	2 N 3906	SGS
T 302	BSX 52 A	Ditratherm
R 303	BFX 68 A	SGS
T 304	BSX 52 A	Ditratherm
T 305, 306	BFX 68 A	SGS

Potentiometer

P 201	5 kΩ	3 % lin 0,25 %	Draht (wire)	Amphenol
P 202...204	100 kΩ lin			
P 205	10 kΩ	3 % lin 0,25 %	Draht (wire)	Amphenol

Kondensatoren (Capacitors)

C 201, 202	10 nF	250 V		
C 203, 204	2,2 nF	500 V	- 20/+ 50 %	Keram.
C 205	3,3 nF	500 V	- 20/+ 50 %	Keram.
C 206	1 nF	1000 V		
C 207, 208	2,2 nF	160 V	2 %	Kunst.-Folie (plastic foil)

Dioden (Diodes)

Gl 201	OA 127	Telefunken
Gl 202	OA 182	Telefunken
Gl 203, 204	BA 110	ITT
Gl 205	OA 182	Telefunken
Gl 208...210	1 N 914/ 1 N 4448	

Transistoren (Transistors)

T 201	2 N 930/BFX 93	SGS
T 202	BCY 34	Valvo
T 203, 206	BFX 68 A 1)	SGS
T 204, 205	BSY 76	ITT
T 207	2 N 708/BSX 88	SGS
T 208	BCY 34	Valvo
T 209...212	BFX 68 A 1)	SGS
T 213, 214	BCY 34	Valvo
T 215	2 N 3251	Motorola

Relais (Relays)

Rel 201, 202	Bv. 322 - 8202

Schalter (Switches)

S 201		Bv. 322- 8001	Winkler
S 202	2polig	B 1 WN 13/4/1	
S 203		Bv. 322 - 8002	Winkler
S 204	2polig	B 1 WN 13/4/1	

1) Serie (Series) K: BSY 54 ITT

Transistoren (Transistors)

T 301, 302	BSY 54	ITT
T 303	ASY 28	Valvo
T 304	BCY 31 S	Valvo
T 305	ASY 28	Valvo
T 306	BCY 31 S	Valvo
T 307...310	BSY 54	ITT
T 311...314	BCY 34	Valvo

Übertrager (Transformer)

Ü 301	Bv. 322 - 7726

C 410	33 nF	125 V	± 10 %	Kunst.-Folie (plastic foil)
C 411	0,1 µF	100 V	10 %	Kunst.-Folie (plastic foil)
C 412	0,33 µF	100 V	10 %	Kunst.-Folie (plastic foil)
C 413	1 µF	100 V	10 %	Kunst.-Folie (plastic foil)
C 414	2,2 µF	100 V	10 %	Kunst.-Folie (plastic foil)
C 415	4,7 µF	100 V	10 %	Kunst.-Folie (plastic foil)
C 416	10 µF	63 V	20 %	Kunst.-Folie (plastic foil)
C 417	100 pF	160 V	2 %	Kunst.-Folie (plastic foil)
C 418	330 pF	160 V	2 %	Kunst.-Folie (plastic foil)
C 419	1 nF	400 V	10 %	Keram.
C 420	3,3 nF	400 V	10 %	Keram.
C 421	10 nF	400 V	10 %	Keram.
C 422	33 nF	125 V	± 10 %	Kunst.-Folie (plastic foil)
C 423	0,1 µF	100 V	10 %	Kunst.-Folie (plastic foil)
C 424	0,33 µF	100 V	10 %	Kunst.-Folie (plastic foil)
C 425	1 µF	100 V	10 %	Kunst.-Folie (plastic foil)
C 426	2,2 µF	100 V	10 %	Kunst.-Folie (plastic foil)
C 427	4,7 µF	100 V	10 %	Kunst.-Folie (plastic foil)
C 428	10 µF	63 V	10 %	Kunst.-Folie (plastic foil)
C 429	15 pF	500 V	5 %	Keram.

Dioden (Diodes)

Gl 401...407	1 N 4448	SEL
Gl 408	ZP 8,2	ITT

Transistoren (Transistors)

T 401	2 N 709	SGS
T 402	2 N 2368	SGS
T 403	2 N 709	SGS
T 404	2 N 2368	SGS
T 405, 406	2 N 2219/BFX 93	Motorola
T 407	BSY 54	ITT
T 408	2 N 2219/BFX 93	Motorola
T 409, 410	BSY 54	ITT
T 411	2 N 918/BFX 73	
T 412	2 N 2708	RCA
T 413	BSY 54	ITT
T 414	2 N 918/BFX 73	

Spulen (Coils)

L 401		Bv. 322 - 7826	
L 402	2,2 µH	1537 - 20	Delevan

Schalter (Switch)

S 401	Bv. 322 - 8003	Winkler

Buchse (Socket)

Bu 401...403	Uni 9 C	WN 119/9/4 + 2 WN 119/9/5

Gl 10	OA 130		Telefunken
Gl 11, 12	AA 132		Telefunken
Gl 13	AA 118		Telefunken

Lampe (Lamp)

SL 1	TFE 505	110 V	Schurter 1)

Sicherung (Fuse)

Si 1	220 V: M 0,08 C 80 mA mittelträge (medium-blow) DIN 41571 110 V: M 0,16 C 160 mA mittelträge (medium-blow) DIN 41571

Netztrafo (Transformer)

Ü 1	Bv. 323 - 7703

Spulen (Coils)

L 1, 2	45 µF	1,5 A
L 3	5 µH	10 A
L 4, 5		Bv. 323 - 0300.07/5

Schalter (Switches)

S 1	2polig	an (combined with) P1
S 2		Bv. 323 - 8001

Buchsen (Sockets)

Bu 1...6	Rel stv 43 a	75 Ω	Siemens
Bu 7, 8	3polig	WN 119/7/1 2)	

Relais (Relays)

Rel 1...8	Magnetspule (Coil)	Bv. 323 - 8281	
	Reed contact	40 AW ± 7,5 MRMF-2	Hamlin

Serie (Series) F: 1) 110 V/0,4 mA 1.90640.001 Rafi
2) Bu 8 entfällt (deleted)

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APPENDIX

Single Units of the Sweep Measuring Set WM-50

Level Measuring Set	PSM-5	BN 444 (dB/V calibration) BN 444/1 (Np calibration)
or		
Generator	PSO-5	BN 442 (dB/V calibration) BN 442/1 (Np calibration)
Receiver	PMO-5	BN 443 (dB/V calibration) BN 443/1 (Np calibration)
Display Unit	SG-1	BN 551
with Display Plug-In Unit	SGE-10	BN 322
Accessories		
Change-Over Relay Unit	RU-3	BN 323
Scale Expander	AZD-1	BN 364 (dB calibration) BN 364/1 (Np calibration)
Probe	TK-8	BN 363
Return Loss Measuring Accessory	RFZ-5	BN 394
Cabinet with mains connection for Display Plug-In Unit SGE-10	SGEG-1	BN 414

1. SPECIFICATIONS

The Sweep Measuring Set WM-50 comprises the Level Measuring Set PSM-5, Display Unit SG-1 and the Display Plug-In Unit SGE-10. The Change-Over Relay RU-3 is an optional accessory of WM-50.

1.1. Level Measuring Set PSM-5

BN 444, dB/V calibration (BN 444/1, Np calibration)

Full PSM-5 specifications are contained in the PSM-5 instruction manual.

1.1.1. RWO-5 Sweep Device / BN 241

Frequency range	10 kHz to 36 MHz
under limited operating conditions [1]	2 kHz to 36 MHz
Sweep Deviation (19 frequ. deviation ranges)	35 Hz to 35 MHz
Accuracy of adj. frequency deviation (ref. $f_{max} - f_{min}$)	± 15 % and better
Accuracy of adj. centre frequency for frequ. deviations in range	
35 Hz to 35 kHz	min. 3 % of adj. deviation range
70 kHz to 1.4 MHz	min. 3 % of adj. deviation range ± 70 kHz
3.5 MHz to 35 MHz	min. 3 % of adj. deviation range ± 500 kHz
10 swept frequency ranges [2]	manual/0.1 Hz/0.2 Hz/0.5 Hz and so on to 20 Hz/50 Hz

External sawtooth voltage input (socket Bu 1601/5)

Peak voltage requirement U_s for adj. sweep deviation	± 3.5 V
Input impedance	10 kΩ

Sawtooth voltage output (socket Bu 1601/1)

Open circuit voltage U_s	± 3.5 V
Output impedance	1 kΩ

---

1) When operating in the narrow band, low noise mode, and with an input signal of at least -60 dB (-7 Np), the measuring set can also be used for a number of measurements at frequencies below 10 kHz.

2) In position '50 Hz' the frequency range can be extended for any frequency below 50 Hz by inserting a capacitor between ground and socket Bu 1601/4. The upper limit of the capacitance is determined by the leakage current which must not exceed 2 μA.

1.1.2. Signal Generator PS-5

BN 242, dB/V calibration (BN 242/1, Np calibration)

Output level (matched)	-85 dB to +2 dB (-9 Np to +0.2 Np)
Output voltage (matched)	approx. 50 µV to 1 V
Output impedance	50, 60, 65, 75, 135 and 150 Ω

Frequency response of output level

Deviation from ref. value at 100 kHz for 0 dB (0 Np) reading and all attenuator settings for 75 Ω matched and frequencies

from 10 kHz to 15 MHz	within ± 0.2 dB (± 0.02 Np)
above 15 MHz to 36 MHz	within ± 0.5 dB (± 0.06 Np)

1.1.3. Level Meter PM-5

BN 243, dB/V calibration (BN 243/1, Np calibration)

Input impedance Z_{in}	50, 60, 65, 75, 135, 150 Ω and $1/\omega\ C_{in}$
Input capacitance C_{in} in position $1/\omega\ C_{in}$ for frequencies up to 15 MHz	30 pF

Receive bandwidth, $\Delta\ a = 3$ dB (0.35 Np)

wideband	± 1.75 kHz
narrow band	± 0.25 kHz

Output socket (Bu 1601) for Display Plug-In Unit SGE-10

d.c. at f.s.d. corresponding to 10 cm Y-deflection on SG-1	6 V
Smallest receive level for 10 cm Y-deflection on SG-1 neglecting inherent interference voltage	lin -110 dB (-12 Np) log - 30 dB (- 4 Np)
Min. variation of level for 1 cm Y-deflection of x10 expanded SGE-10	lin 0.1 dB (0.01 Np) or 1 %
Max. indicated level difference for 10 cm Y-deflection without change of sensitivity	log 100 dB (10 Np)
Max. permissible receive level	+22 dB (+2.2 Np)

1.2. Display Plug-In Unit SGE-10 / BN 322

All of the following values are valid for operation of the plug-in in Sweep Measuring Set WM-50.

1.2.1. Modes of Operation

Measuring procedure without Change-Over Relay RU-3

Ref. line OFF : object I - zero line - object I - zero line...

Ref. line ON : object I - zero line - ref. line - zero line - object I...

Measuring procedure with Change-Over Relay RU-3

Ref. line OFF : object I - zero line - object II - zero line - object I...

Ref. line ON : object I - zero line - ref. line - zero line - object II - zero line - ref. line - zero line - object I...

Horizontal Deflection

Waveform of increasing frequency on Display Unit optional to left or right

Vertical Deflection

Alternate display of gain (zero line on lower graticule edge, switch S 204 in position ∨) or attenuation (zero line on upper graticule edge, S 204 in position ∧)

1.2.2. Frequency Markers

Signal frequency f_1

Frequency range . . . . . 10 kHz to 36 MHz

Peak input voltage U_s (sinusoidal or square 1 : 1) . . . . . 0.3 V to 10 V

Input impedance . . . . . 75 Ω

Marker frequency f_2

Frequency range . . . . . 10 kHz to 5 MHz or 1 kHz to 10 MHz [1)]

Peak input voltage U_s (sinusoidal or square 1 : 1). . . . . 0.3 V to 10 V

Input impedance . . . . . 75 Ω

Marker frequency band

for marker frequency 1 to 10 kHz . . . . . min. 1 MHz

for marker frequency 10 to 100 kHz . . . . . min. 6 MHz

for marker frequency 0.1 to 10 MHz . . . . . min. 36 MHz

---

1) When adjusting for these values the resulting marker quality will deteriorate: the markers can occasionally show gaps and sometimes fail.

Sideband frequency f_3 [1)]

Frequency range	≦ 500 kHz
Peak input voltage (sinusoidal or square 1 : 1)	2 V to 5 V
Input impedance	150 Ω to 300 Ω

1.2.3. Y-Deflection

Y-expansion	× 1/× 2/× 5/× 10
Accuracy of expansion coefficient	± 3 % and better

Y-Shift

When Y-expansion is switched, any section of the picture can be displayed

Superimposed marker amplitude

Marker height, adjustable	0 to 3 cm

Reference line (socket Bu 201/1)

adjusting range	0 to 10 cm
Accuracy when adjusted by PM-5 meter, ref. to value indicated	1 % and better

1.2.4. General Ratings of the Plug-In Unit

Y-input (socket Bu 201/5)

Input voltage requirement	0 to +6 V
Input impedance	> 20 MΩ
Spurious d. c.	< 1 μA

X-input (socket Bu 202/1)

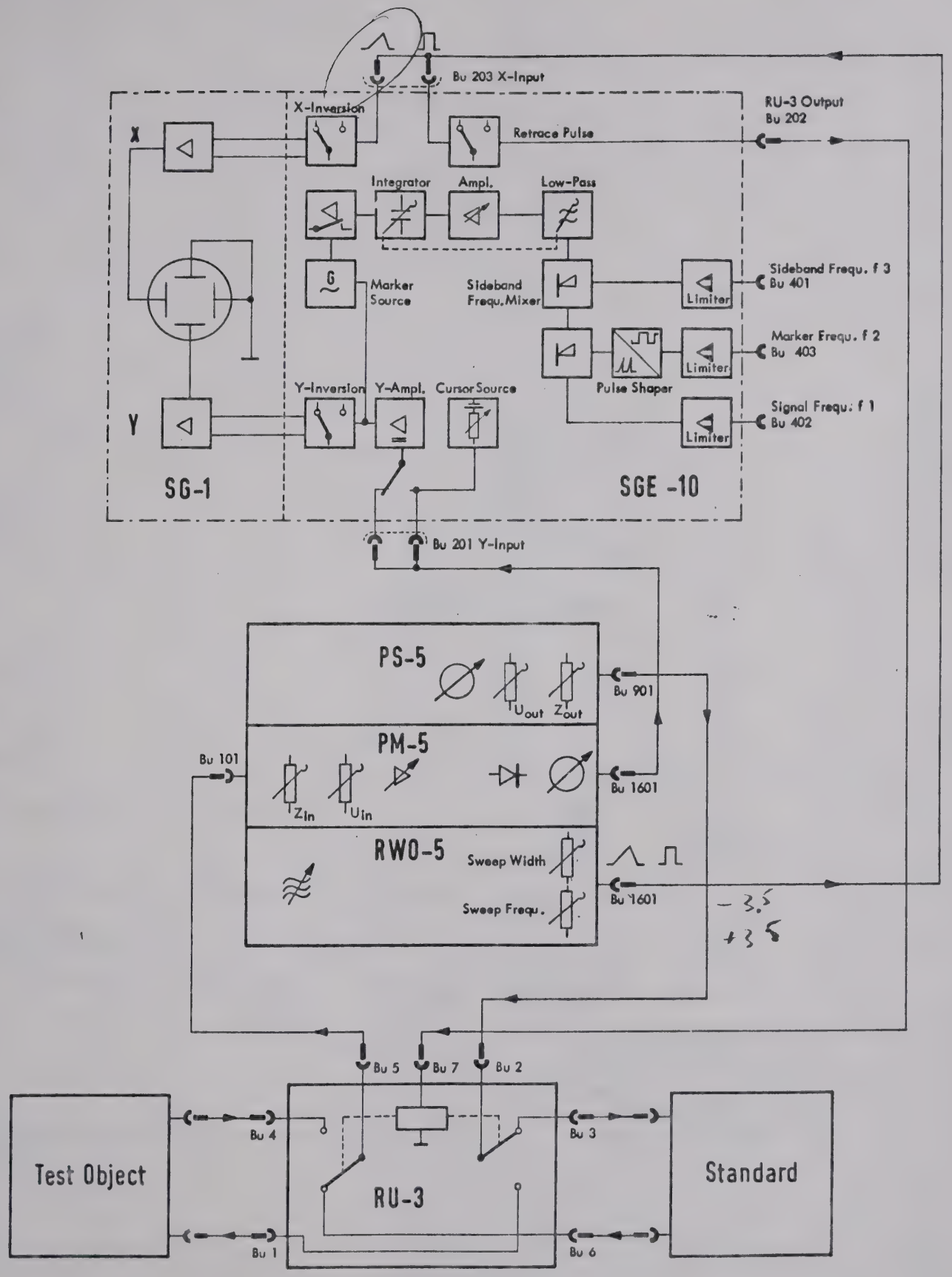
Input voltage requirement (saw-tooth)	± 3.5 V
Input impedance	133 kΩ

Retrace Pulse required (socket Bu 203/2)

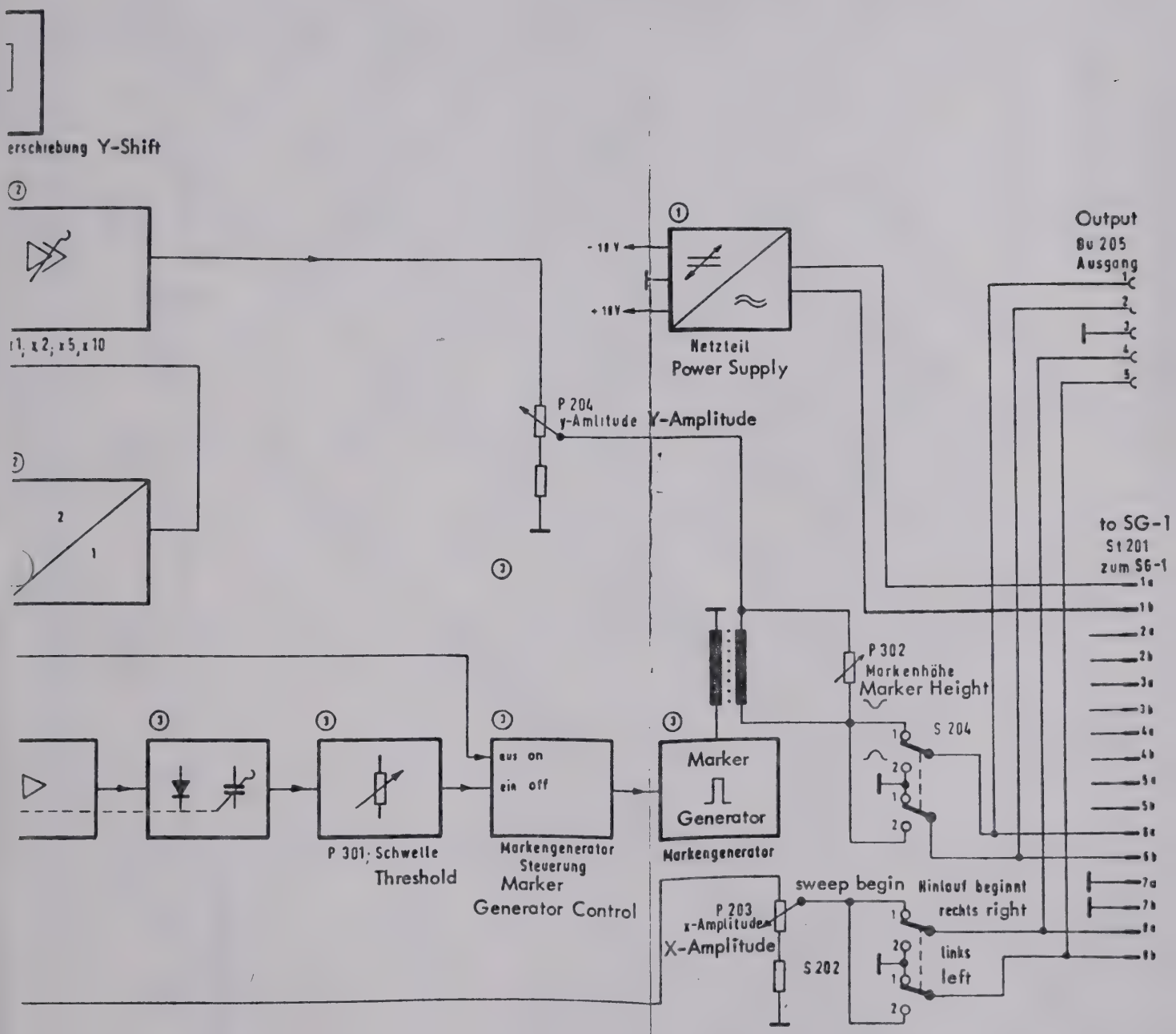
Pulse base	0 to +0.5 V
Pulse crest	+6 V
Rise time	< 100 μs
Pulse duration	> 4 ms

---

1) When applying the voltage for the sideband frequency, the band centre marker disappears : in its place the two sideband markers appear.



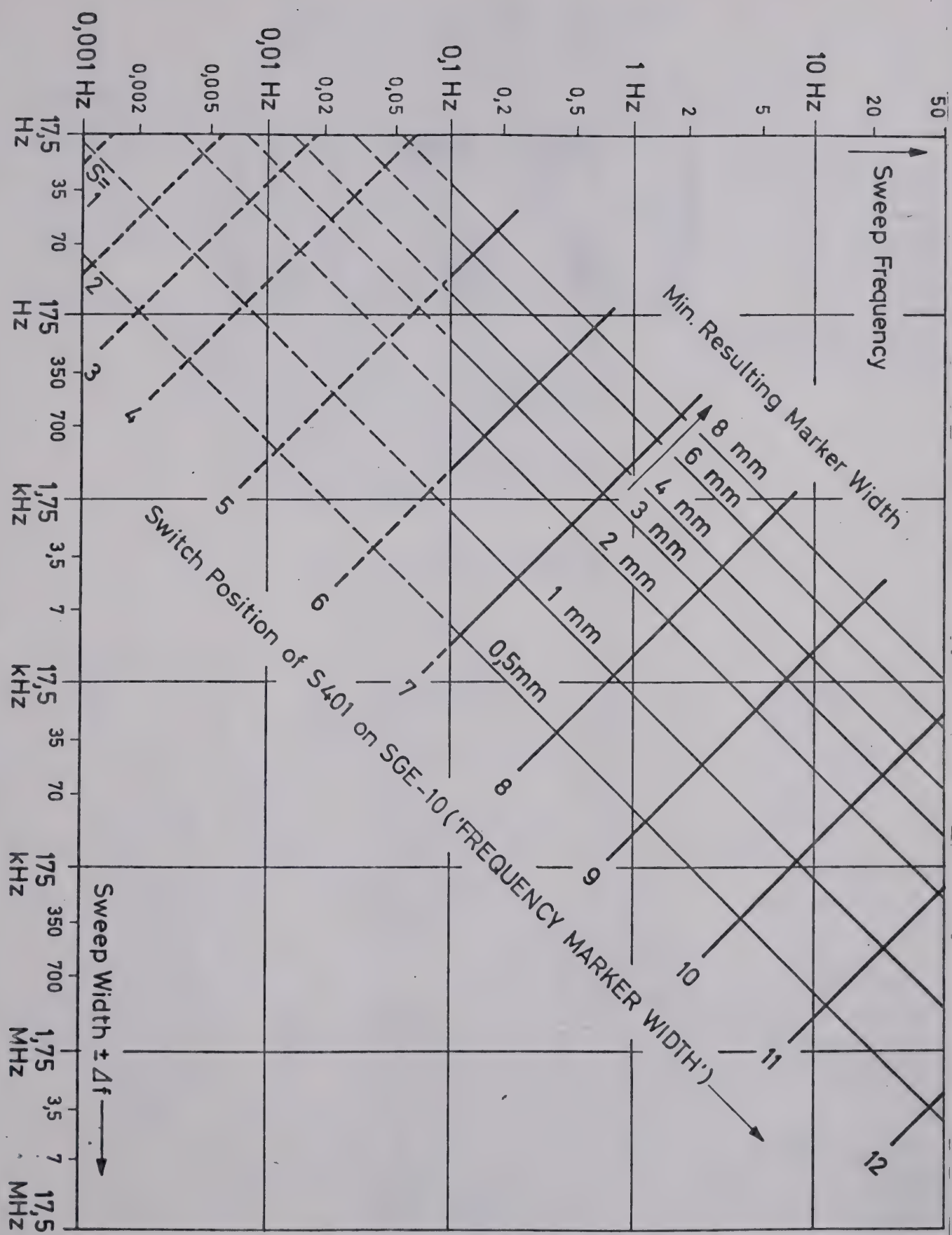
WM-50 Block Circuit Diagram



SGE-10/BN 322

Blockschaltplan

(Block Circuit Diagram)



Setting-Up Procedure for Frequency Markers

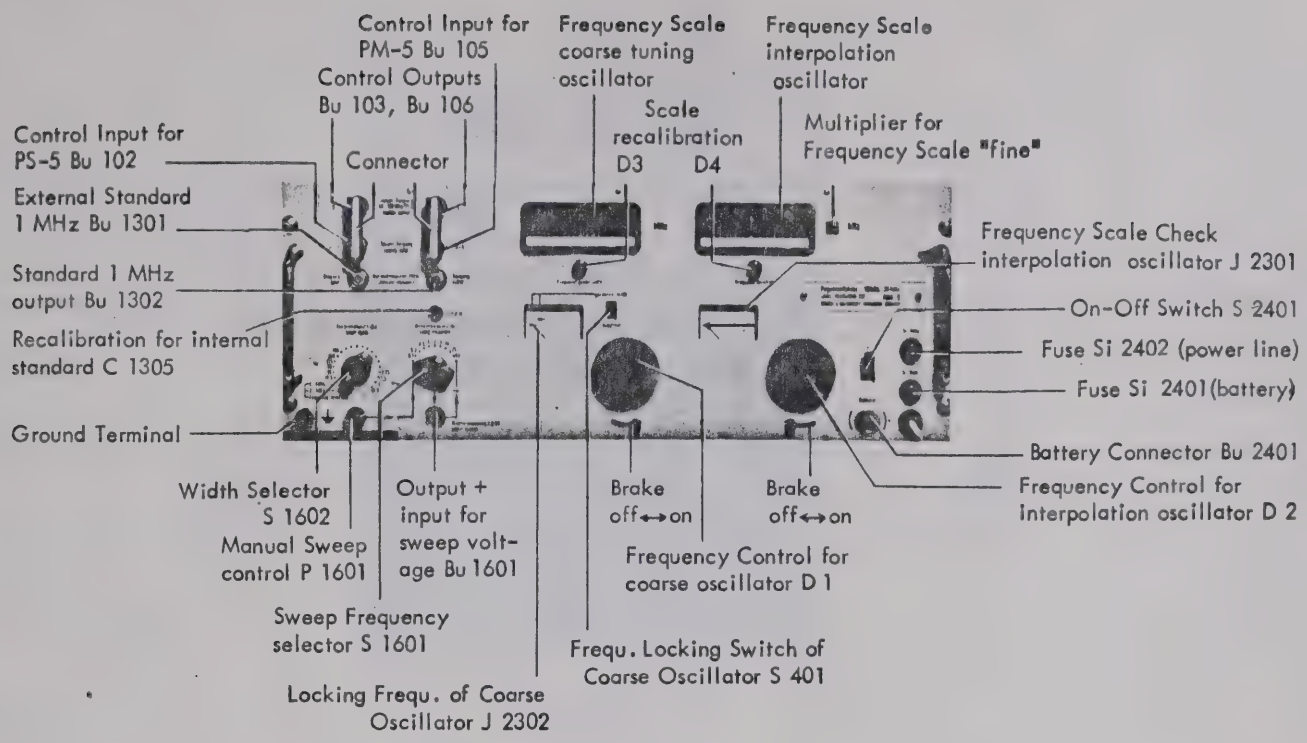


Fig. 1 Oscillator Unit RWO-5

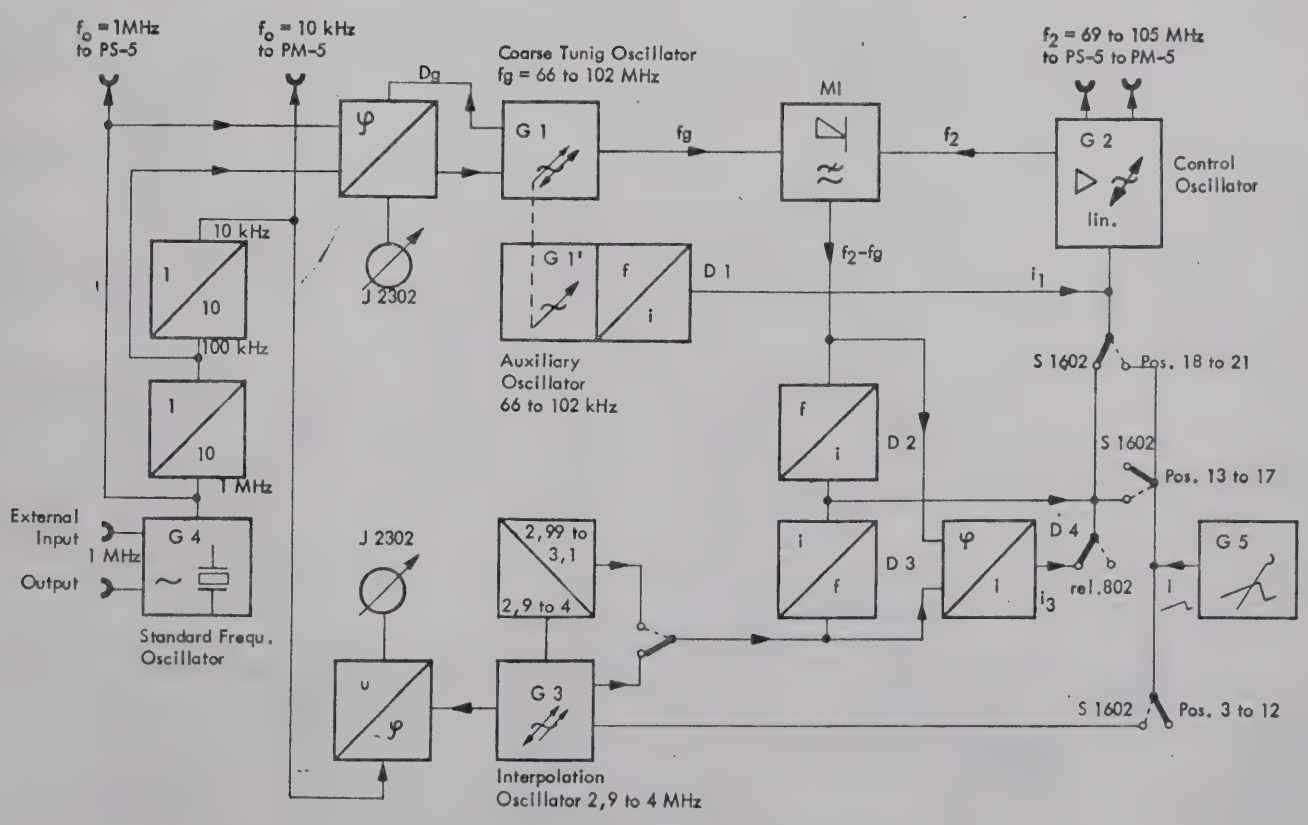


Fig. 2 RWO-5 Block Circuit Diagram

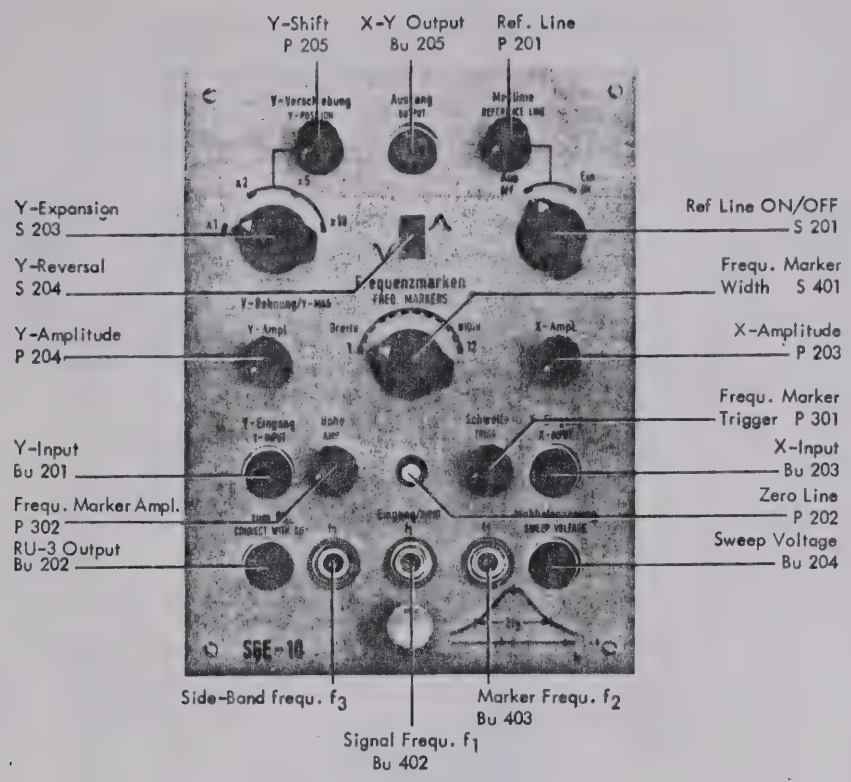


Fig. 7 Display Plug-In Unit SGE-10

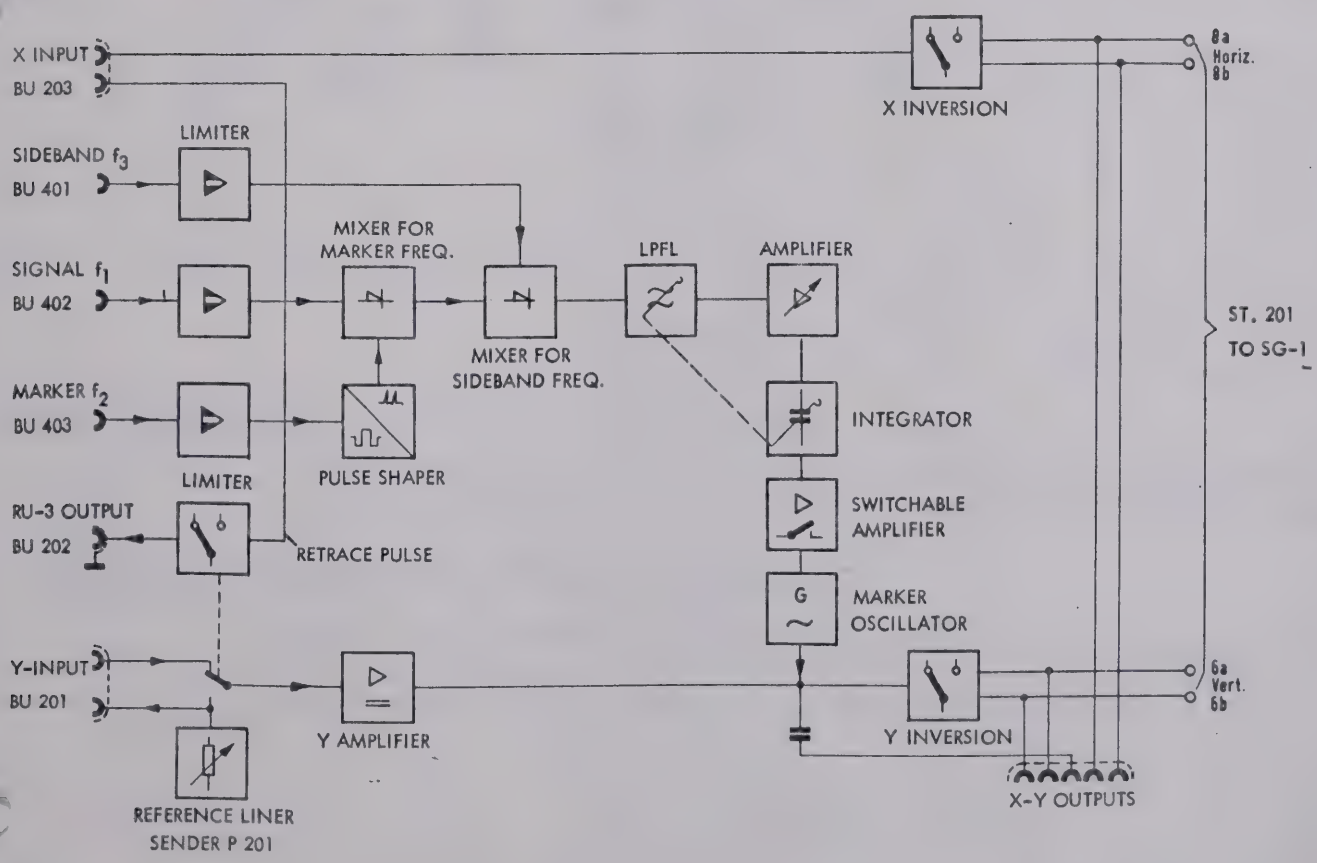
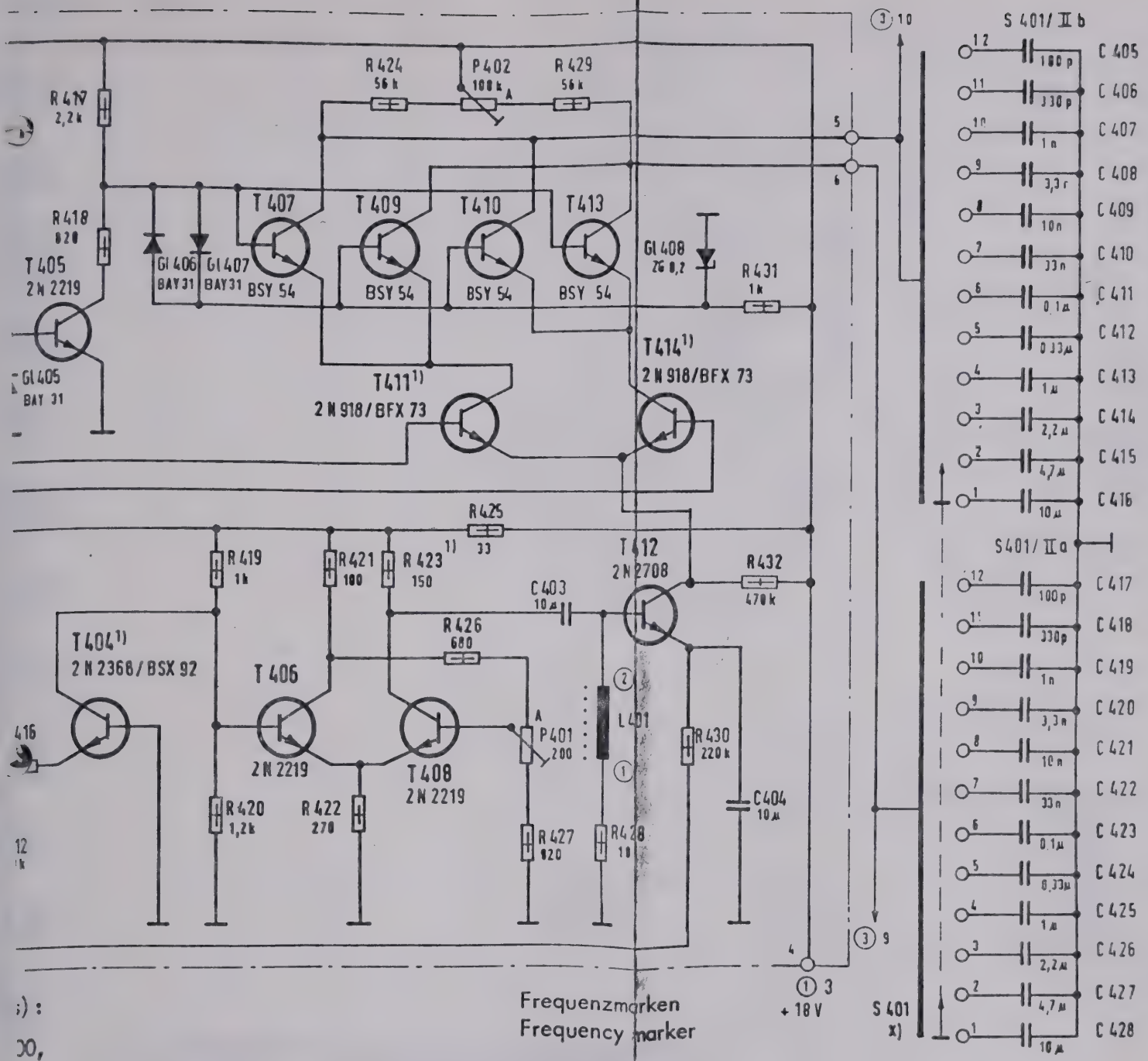


Fig. 8 SGE-10 Block Circuit Diagram



;) :

00,
404, T 411, T 414 / DW 6723

Frequenzmarken
Frequency marker

Breite
Width

S 401

x) Ebene Ia auf Stromlaufplan (3)
Switch wafer Ia of circuit diagram

BSY 54
2 N 709
2 N 2219/BFX 97
2 N 2368/BSX 92
2 N 2708

E
B
C

Belastbarkeit der Widerstände (Resistor Ratings):

1/4 W 1/3 W 1/2 W ab 1 W röm. Ziffern (roman numerals upwards from 1 W)

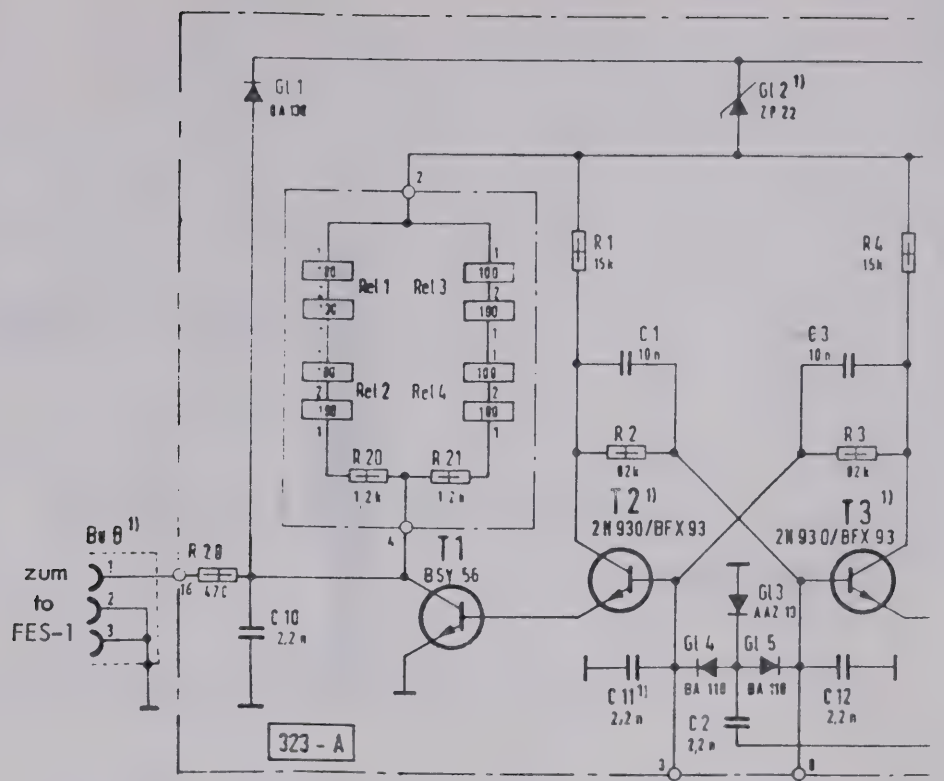
= 1,4 oder (or) 2 W

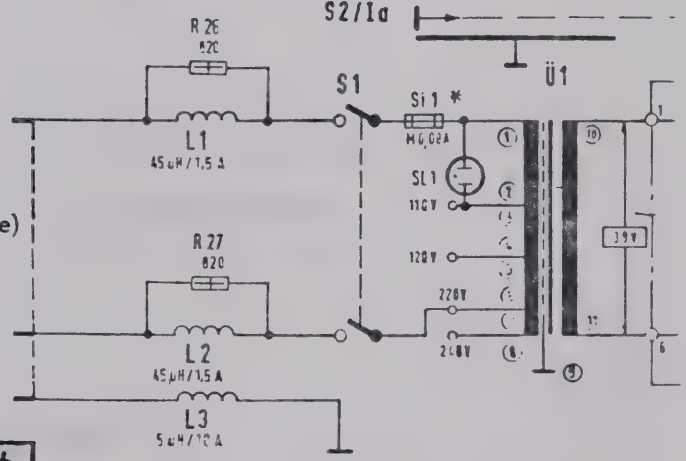
BAY 31
ZG 8,2

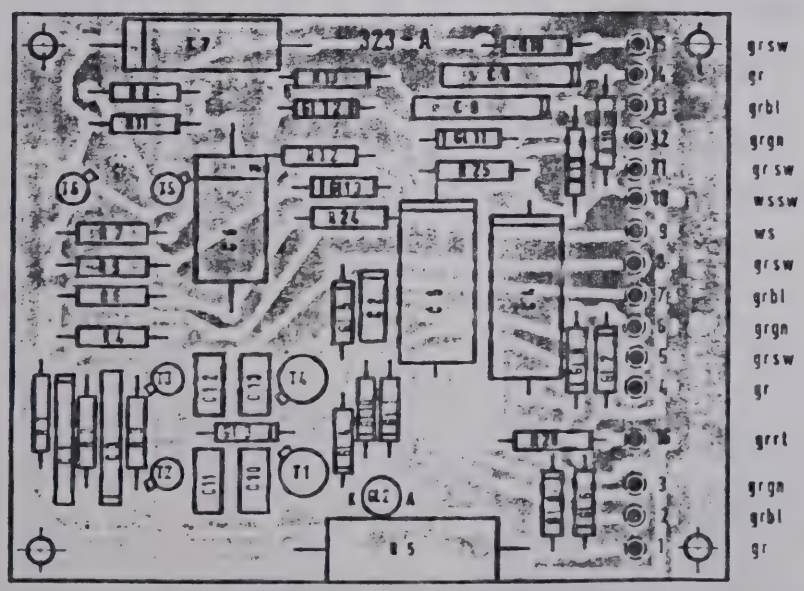
SGE-10 / BN 322

Frequenzmarkengeber HF-Teil (4)

(Frequency Marker Generator, RF Section)







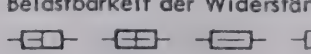
* Si 1 für (for) 110 V = /

gesch. Leitung (shielded cable)

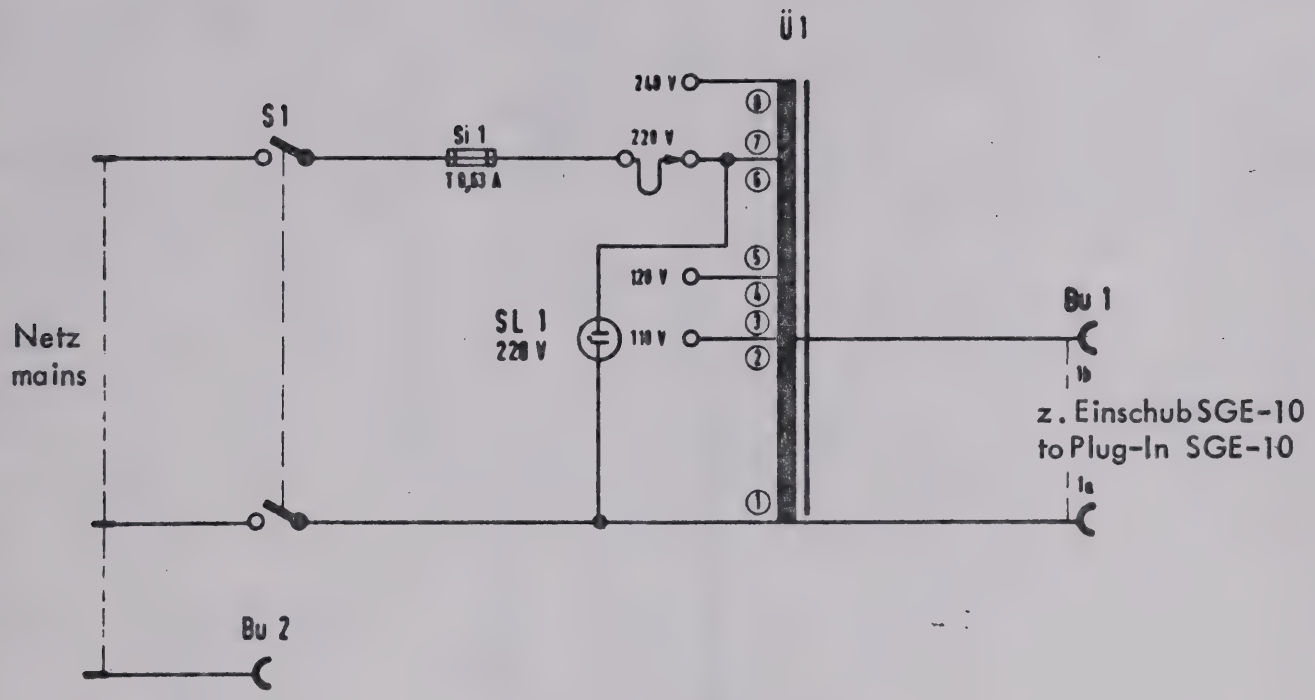
Anmerkung (Note):

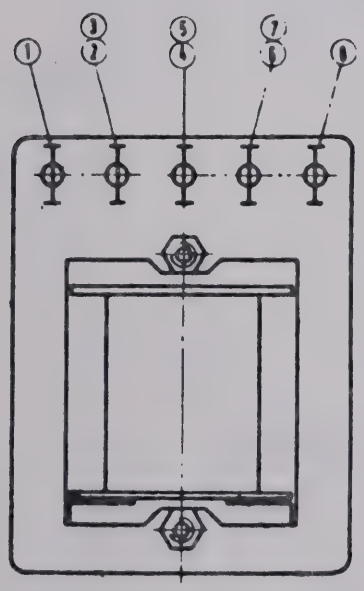
1) Serie (Series) F: Bu 8, I
T 2, T

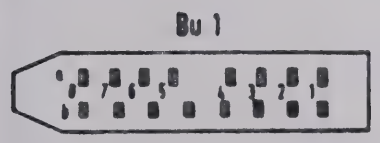
Belastbarkeit der Widerstän



1/3 W 1/4 W 1/2 W ab







auf Lötseite gesehen
showing solder tags

Sicherung (Fuse)

Si 1 T 0,63 B 0,63 Amp.träge (slow-blow)

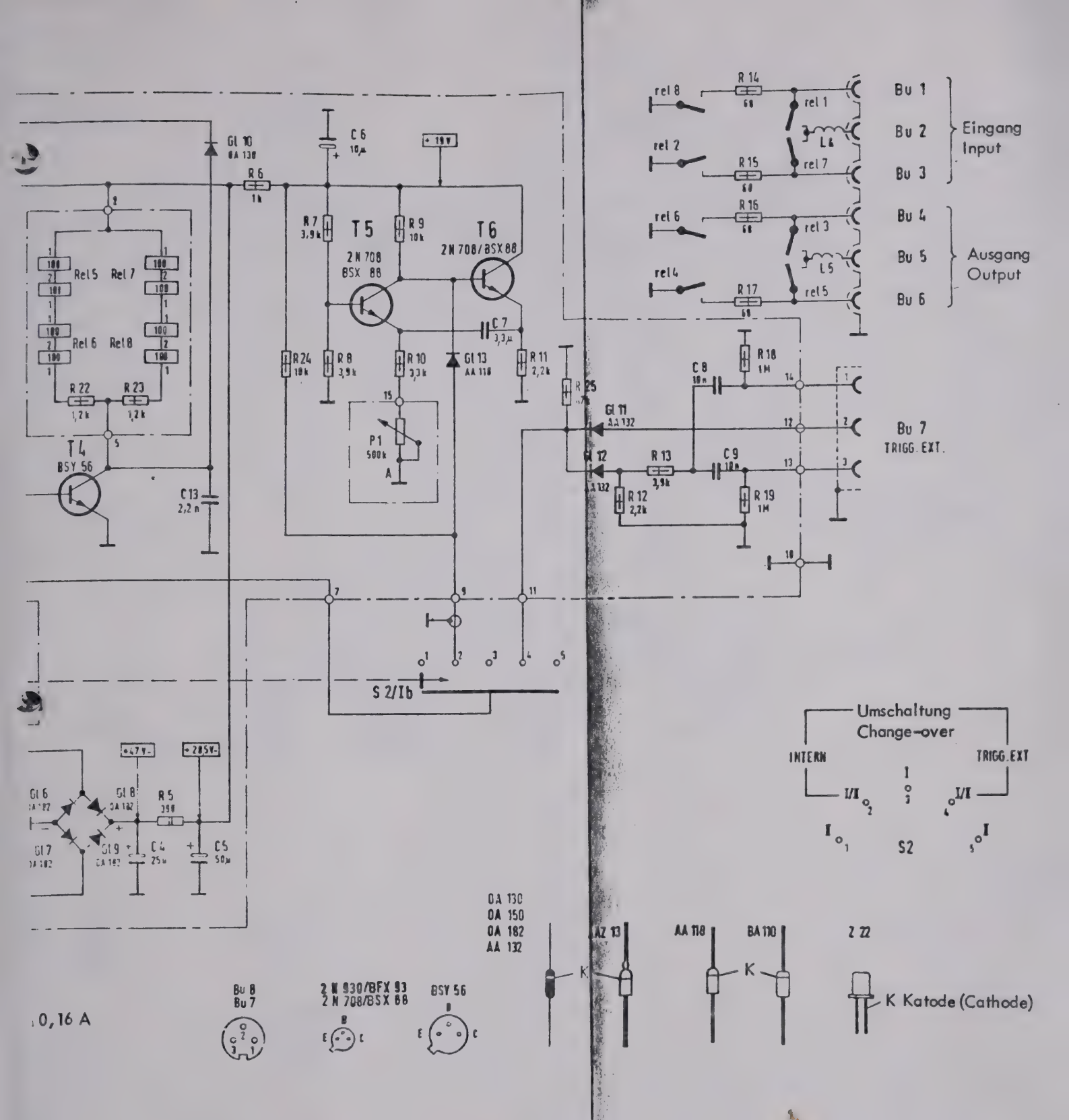
Lampe (Lamp)

SL 1 220V/0,2 mA Glimmlampe (indicator lamp)

SGEG-1/BN 414

Gehäuse mit Netzanschluß
für Sichtgerät-Einschub SGE-10

Housing with mains connection for Display
Plug-In Unit SGE-10



0,16 A

28 entfallen (deleted);
3/2 N 708/BSX 88; Gl 2/Z 22

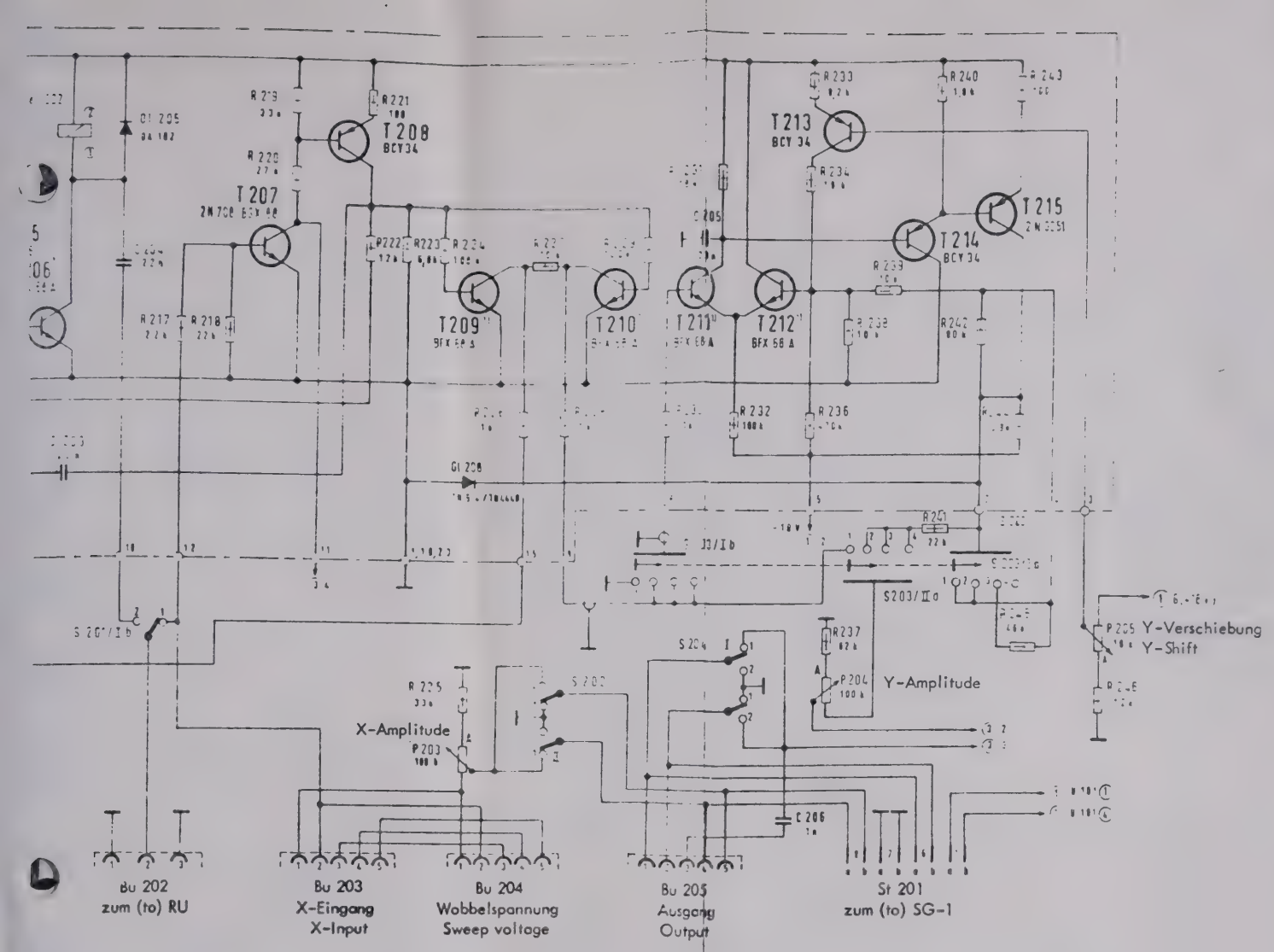
de (Resistor ratings)

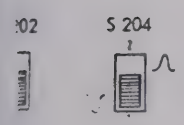
1 W röm. Ziffern (above 1 W rom. numerals)

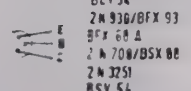
RU-3 BN 323

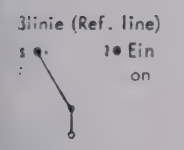
Relais - Umschalter

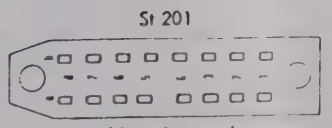
(Change-over Relay Unit)











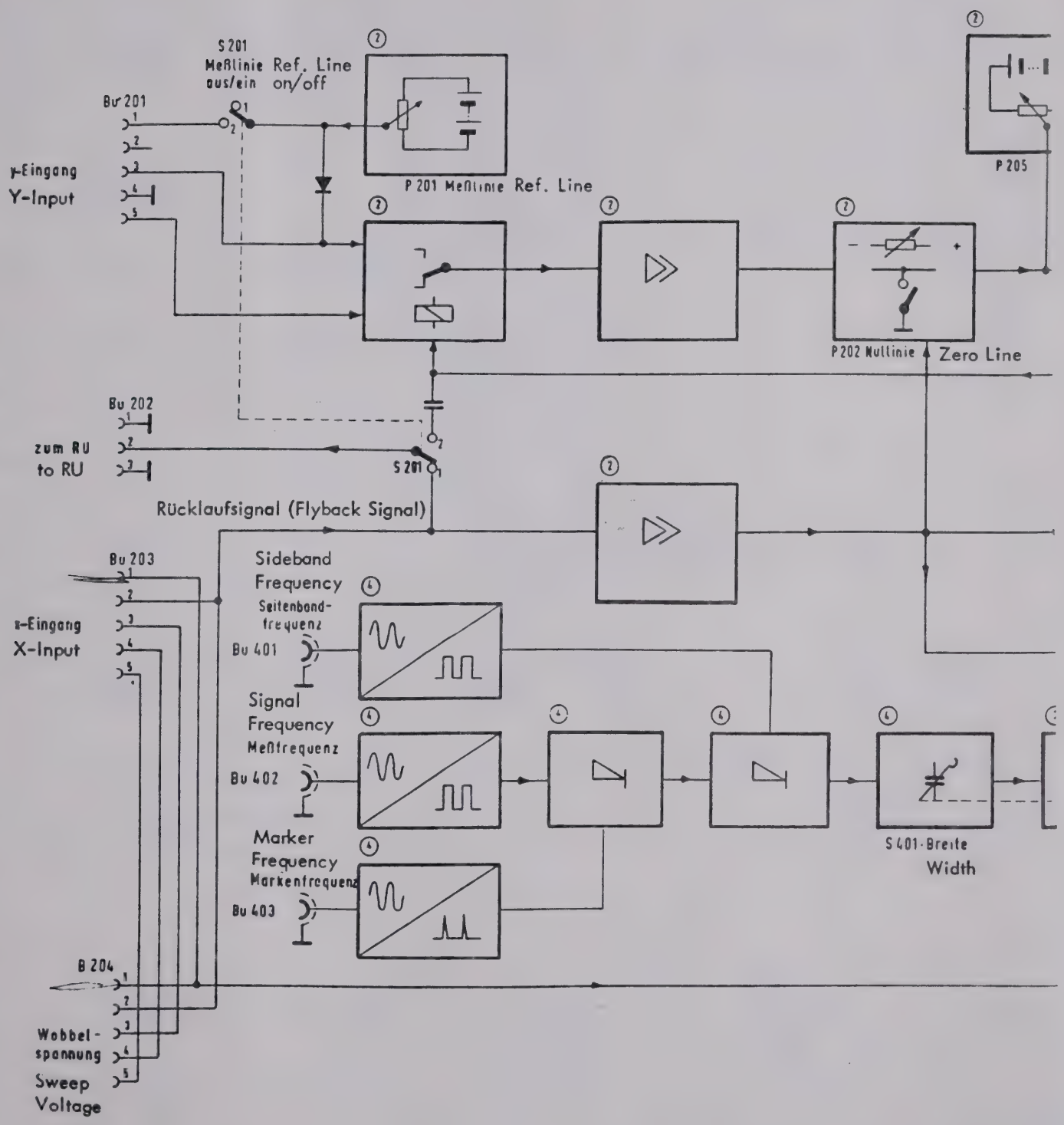
Auf Lötseite gesehen
Showing solder tags

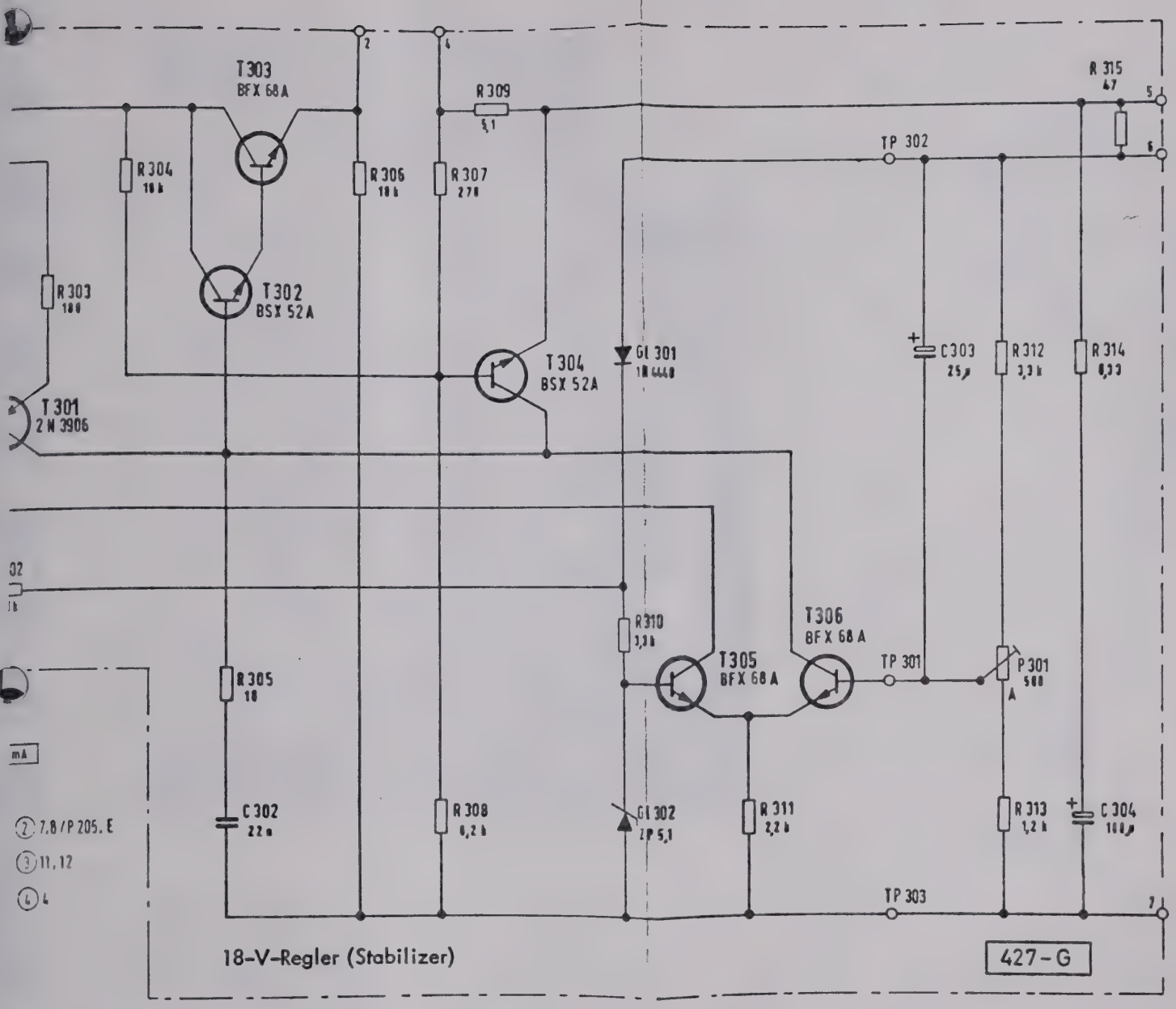
Bu 201,203,204,205

SGE-10 BN 322 (2)

Y-Verstärker

(Y-Amplifier)


S 201
Meßlinie Ref. Line
aus/ein on/off
Bu 201
y-Eingang
Y-Input
P 201 Meßlinie Ref. Line
P 205
P 202 Nullinie
Zero Line
Bu 202
zum RU
to RU
S 201
Rücklaufsignal (Flyback Signal)
Bu 203
x-Eingang
X-Input
Sideband
Frequency
Seitenband-
frequenz
Bu 401
Signal
Frequency
Meßfrequenz
Bu 402
Marker
Frequency
Markenfrequenz
Bu 403
S 401 Breite
Width
B 204
Wobbel-
spannung
Sweep
Voltage



BFX 68 A
BSX 52 A

2 N 3906

ZP 5,1

OA 182
1 N 4448

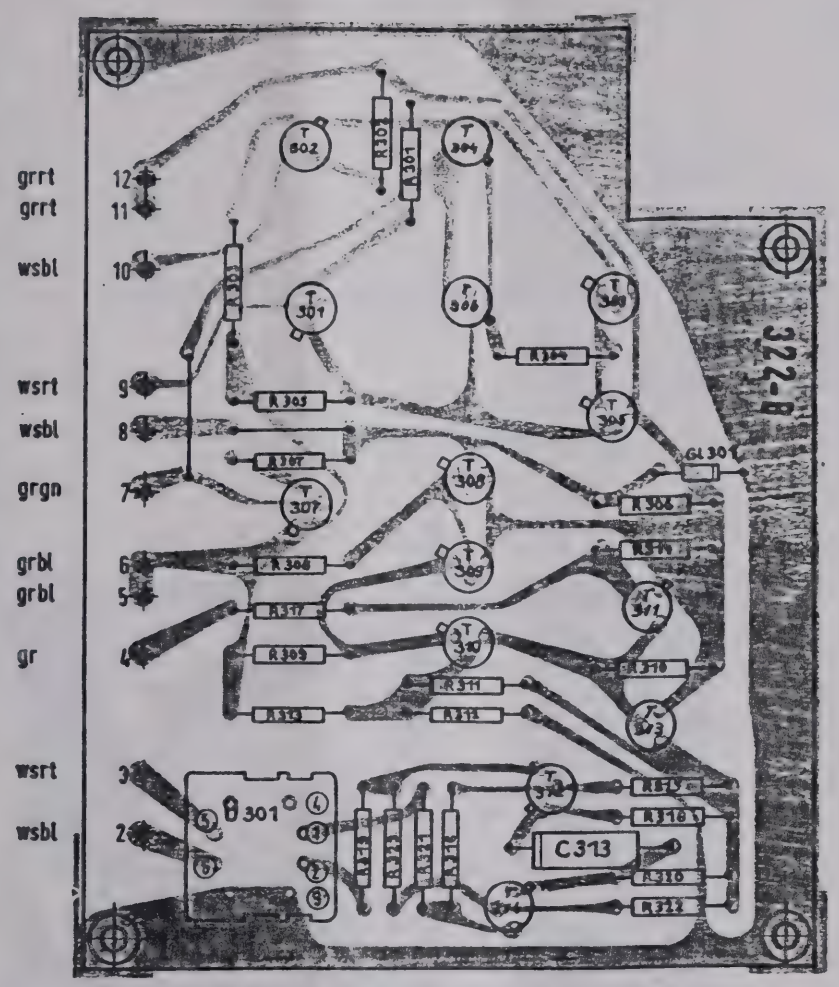
mA

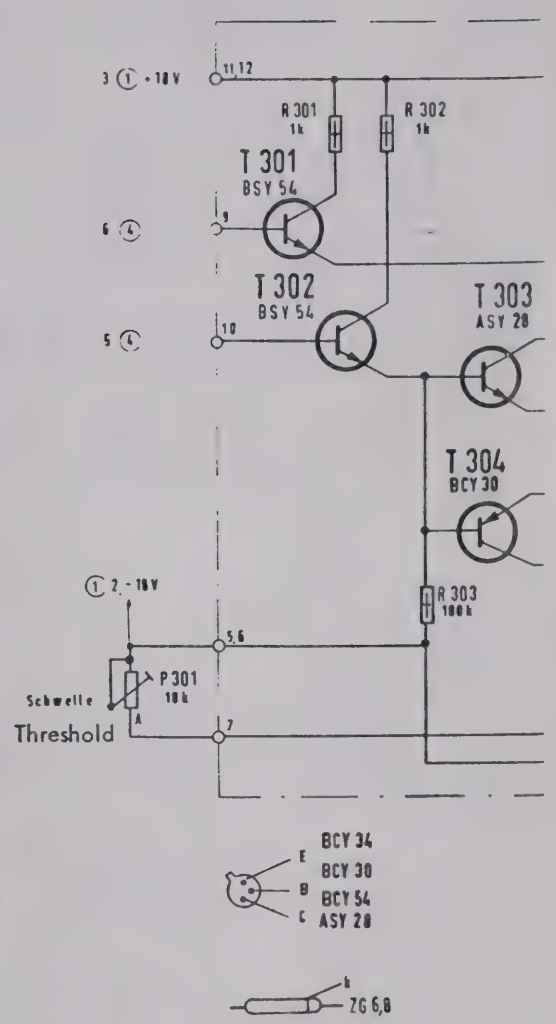
13, 14, 5
5, 6
7, 4

SGE-10/BN 322

Netzteil (1)

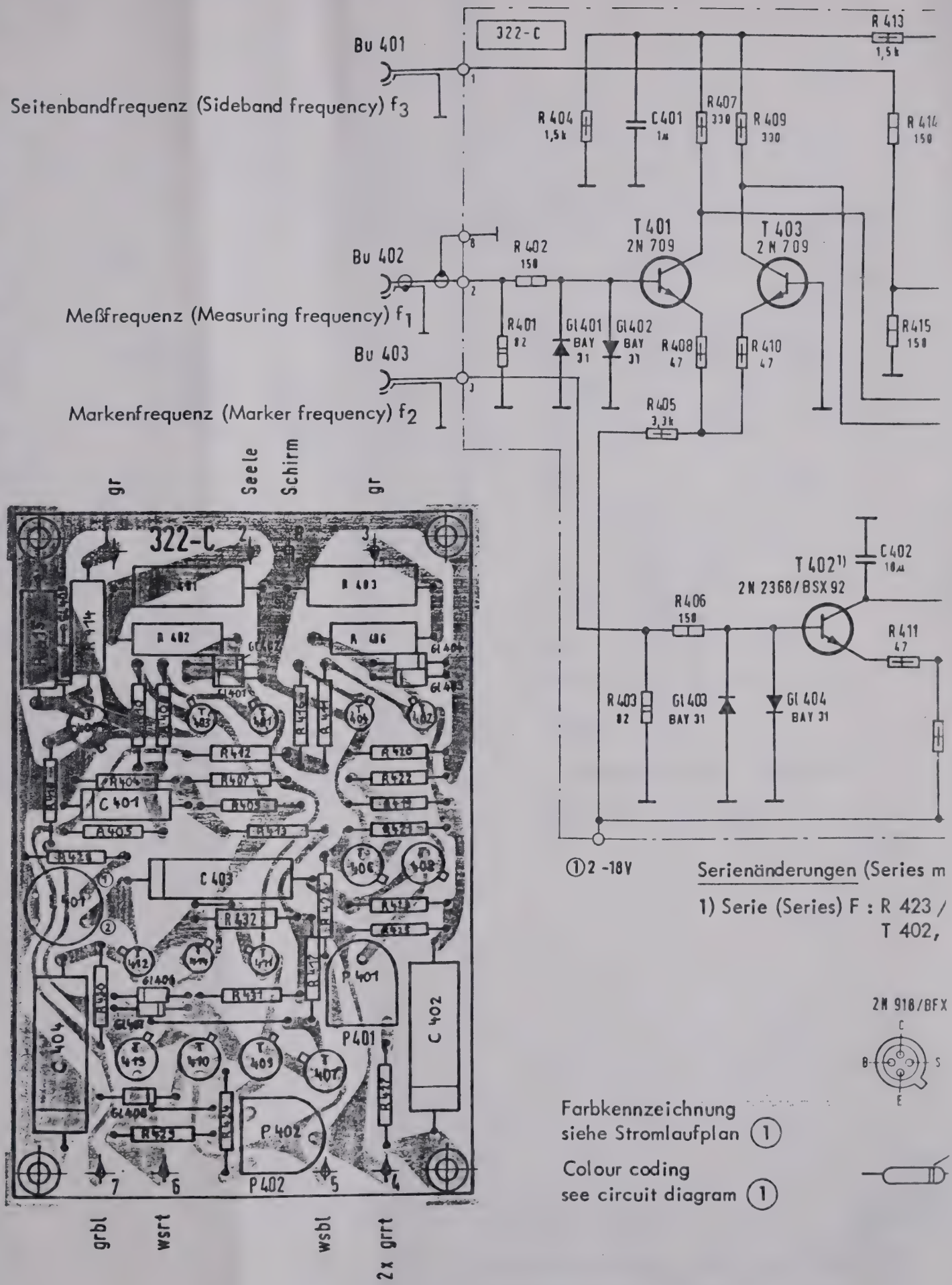
Power Supply

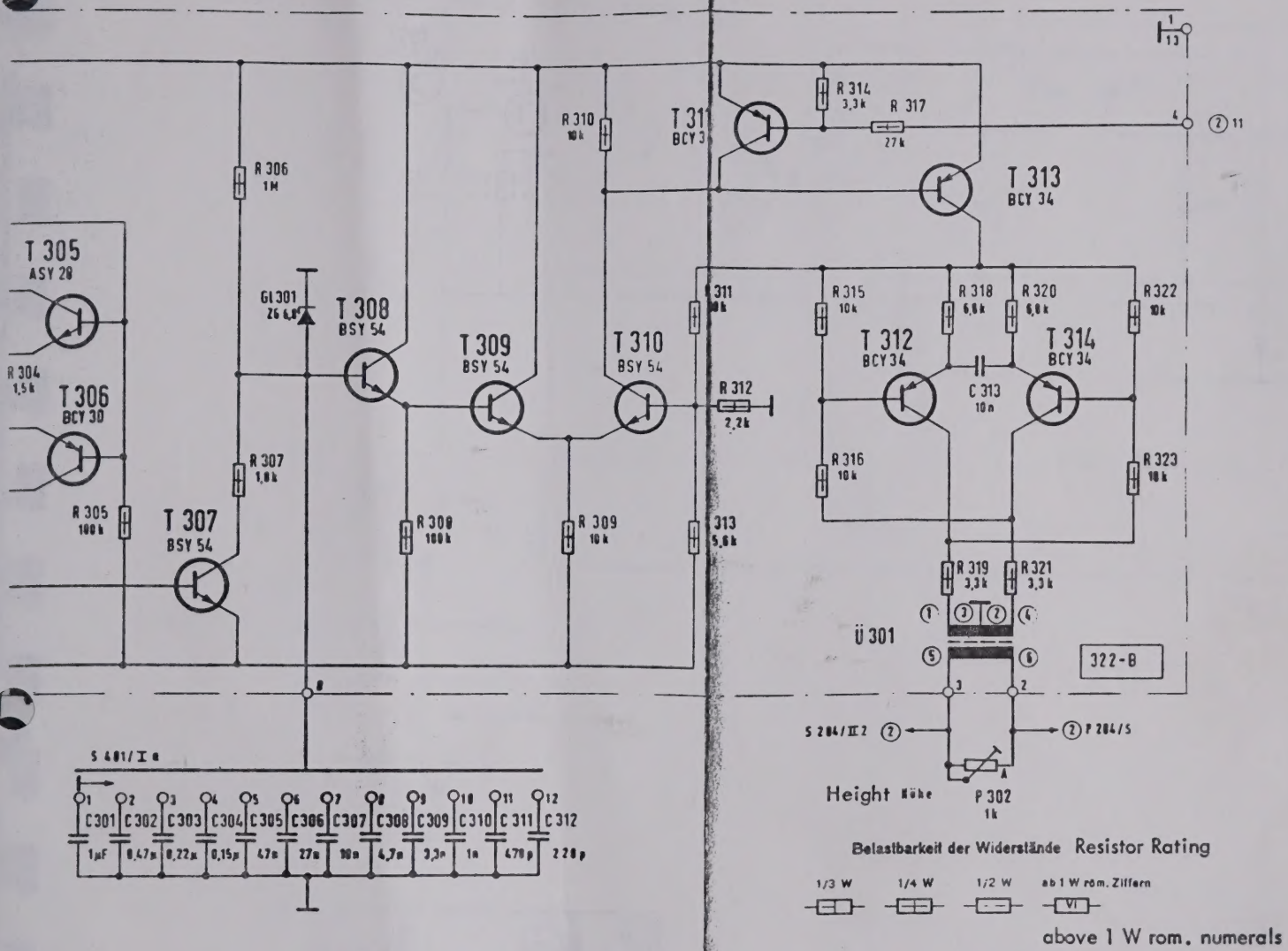




Farbkennzeichnung
siehe Stromlaufplan (1)

Colour Coding
see Circuit Diagram (1)


322-C
Bu 401
Seitenbandfrequenz (Sideband frequency) f3
Bu 402
Meßfrequenz (Measuring frequency) f1
Bu 403
Markenfrequenz (Marker frequency) f2
R 413 1,5k
R 404 1,5k
C 401 1µ
R 407 330
R 409 330
R 414 150
T 401 2N 709
T 403 2N 709
R 402 150
R 401 82
Gl 401 BAY 31
Gl 402 BAY 31
R 408 47
R 410 47
R 415 150
R 405 3,3k
C 402 10µ
T 402 1) 2N 2368/BSX 92
R 406 150
R 411 47
R 403 82
Gl 403 BAY 31
Gl 404 BAY 31
1) 2 -18V
Serienänderungen (Series m
1) Serie (Series) F : R 423 / T 402,
2N 918/BFX
C
B
S
E
Farbkennzeichnung siehe Stromlaufplan 1
Colour coding see circuit diagram 1
gr
Seele
Schirm
gr
grbl
wsrt
wsbl
2x grrt
C 401
C 403
C 404
C 402
P 401
P 402



Belastbarkeit der Widerstände Resistor Rating

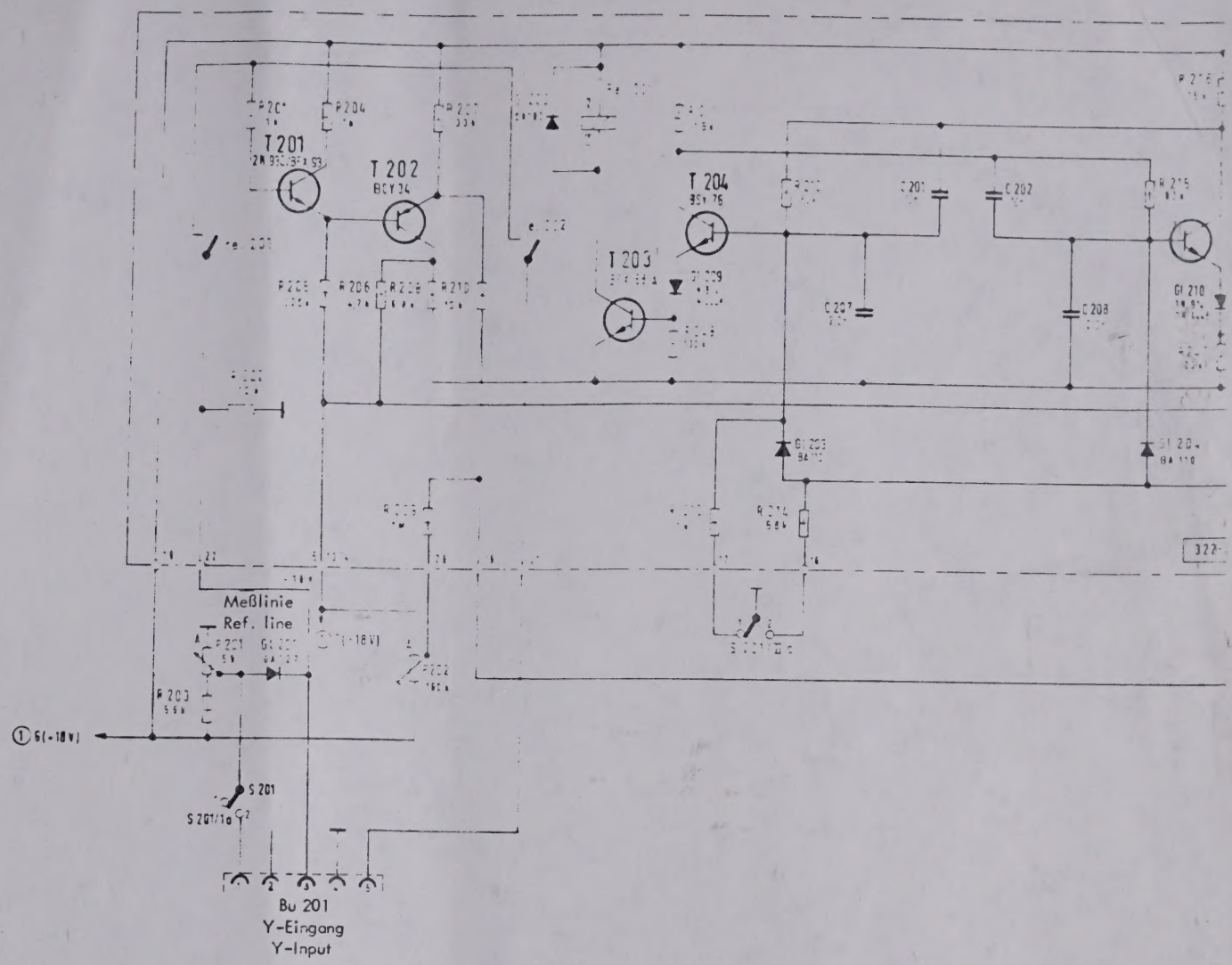
1/3 W 1/4 W 1/2 W ab 1 W röm. Ziffern

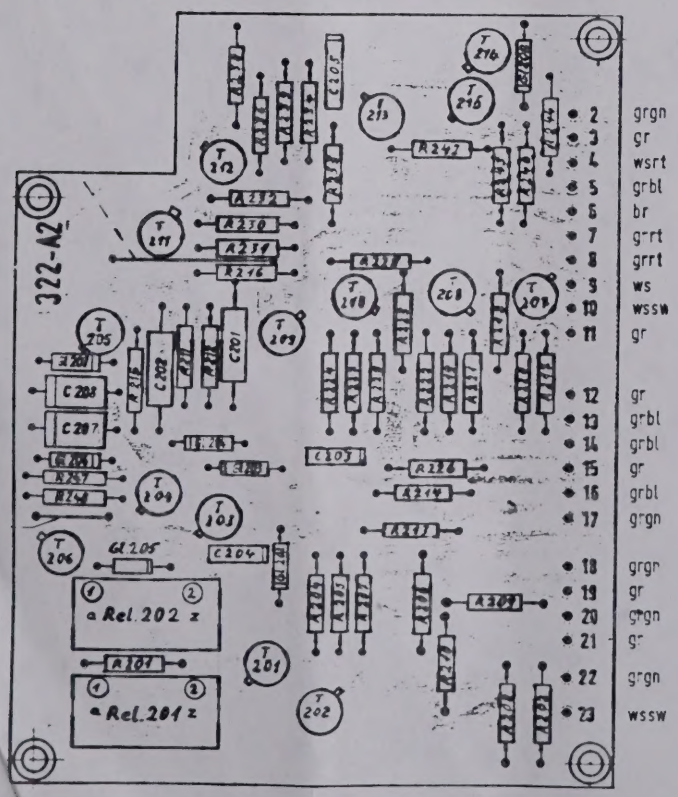
above 1 W rom. numerals

SGE-10 / BN 322

Frequenzmarkengeber NF-Teil (3)

(Frequency Marker Generator, LF Section)





Farbkennzeichnung (Colour Coding)

bl	blau	blue
br	braun	brown
fl	farblos	blank
gn	grün	green
gr	grau	grey
rt	rot	red
sw	schwarz	black
ws	weiß	white
grrt	grau/rot	grey/red

Anmerkung (Note):

1) Serie (Series) K: BSY 54

Belastbarkeit der Widerstände (Resistor ratings)

1/4 W 1/3 W 1/2 W ab 1 W röm. Ziffern (roman numerals above 1 W)